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ABSTRACT

A syllabus is provided for a comprehensive foundation course in mechanical drawing and design for grades 9, 10, 11, or 12 that is prerequisite to advanced elective courses. Introductory materials include course objectives, an overview of basic concepts, and guidelines for implementation. Brief discussions of and suggestions for the areas of design and freehand sketching follow. A section on mechanical representation is divided into these general areas: drafting instruments, lettering, geometric constructions, orthographic projection, dimensioning, pictorial representation (isometric, oblique, exploded views, and perspective), sectional view, auxiliary view, development, and intersections. An introduction, a list of basic knowledge concepts, and suggested activities are provided for each area. Suggestions are also made for further study in creative areas (architectural design and drawing; industrial and product design; tool and equipment design; charts, graphs, and monograms; and applied design) and technical areas (working drawings, electrical drawings, cams and gears, and common fasteners). An introduction, basic knowledge concepts, and suggested activities are provided for each area. A brief discussion of advanced elective courses and a flow chart of courses conclude the syllabus. (YLB)

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MECHANICAL DRAWING AND DESIGN

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FOREWORD

"Mechanical Drawing and Design" is a comprehensive foundation course which may be offered in grade 9, 10, 11, or 12, and is prerequisite to advanced elective courses as described in the section "Advanced Elective Courses." It supersedes "Creative Mechanical Drawing."

"Mechanical Drawing and Design" was developed under the direction of Vincent J. Popolizio, Chief, Bureau of Art Education, in cooperation with Arthur Ahr, formerly Chief, Bureau of Industrial Arts Education (retired); Arthur J. Dudley, Chief, Bureau of Industrial Arts Education; C. Thomas Olivio, Director, Division of Industrial Education, and Robert S. Seckendorf, formerly Chief, Bureau of Occupational Education Supervision, now Assistant Commissioner for Occupational Education.

The course description was written by Marilyn Mikulsky, Assistant Professor, Art Department, Hunter College, The City University of New York, and Walter K. McEnaney, Chairman, Industrial Arts Department, Wantagh High School. The book was designed by Professor Mikulsky.

For the Bureau of Secondary Curriculum Development, editorial guidance was given by Richard G. Decker, Associate in Secondary Curriculum, in consultation with G. Earl Hay, Supervisor of Vocational Curriculum.

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OBJECTIVES

The course in mechanical drawing and design introduces the student to a universal, graphic language through which he can express his own creative ideas with clarity and exactness. During the first year he should spend the majority of the time learning the fundamental methods for this expression while developing a degree of proficiency in sketching and in the use of the draftsman's instruments and equipment. The remainder of the time should be devoted to an exploration into one or more of the specific areas of further study.

Specific objectives of the course are to:

Provide every student with an understanding of drawing as a universal expression

Introduce and expose students to the knowledge, concepts, and techniques involved in a universal drawing language

Help every student communicate ideas, relationships, and facts graphically

Foster the growth of imagination and perspective ability

Develop effective working habits, a feeling of responsibility, and the ability to plan and execute work independently and in cooperation with others

Study basic design principles to insure maximum creative individual and group development

Stimulate an awareness in the comparative qualities of forms in relation to their appearance, function, and intrinsic use of materials

Foster the understanding of related manipulative skills and their relationship to the actual creation of designed objects

Develop the essential understandings and habits in the use of basic tools of the draftsman

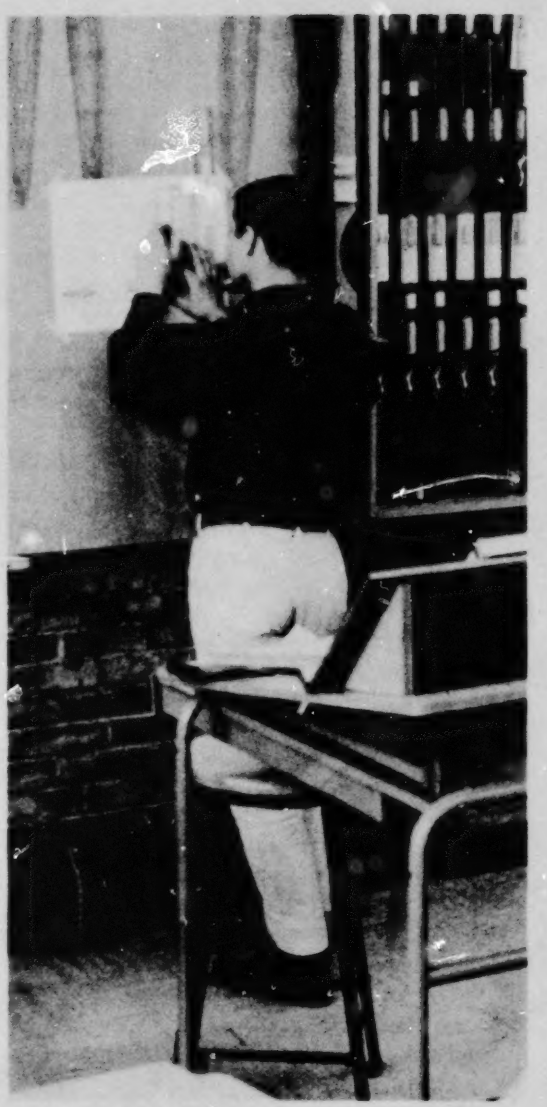
Help the student discover aptitudes and abilities for consideration in future educational experiences.

Drawing as a creative means of expression is usually associated, classified, and emphasized as a vehicle for philosophic inquiry into the nature of human experience through painting, sketching, and graphic arts. In this sense, drawing is primary — a direct communication of our experiences. Its expressions are free and unhampered by methods or standards. It is the experience, technique, and form all in one — pure and complete.

On the other hand, drawing is directly related to other art forms which might be termed primarily utilitarian or applied arts. Industrial design, interior design, stage design, architecture, and city planning are truly creative activities by which man controls and shapes his environment. Here drawing is not the complete act but rather a phase in the development of a creative act. The artist uses drawing to formulate and transfer ideas into actual form. This type of drawing is generally identified as technical or mechanical drawing.

Mechanical drawing is a universal language. It is the graphic language used to express and record ideas, relationships, and facts. As a language there are basic concepts, practices, and standards necessary to achieve varied kinds and levels of expression. As these techniques of expression are learned, they are most meaningful when used in the development of constructive imagination and visual perceptive ability.

Mechanical drawing and design is an integral part of general education. Its main objective in the secondary schools is to expose students to the concepts and techniques involved in this universal drawing language as a means of creative and technical expression.



GUIDELINES FOR IMPLEMENTATION

The beginning course in mechanical drawing and design is an elective course designed to meet the needs and interests of high school students. Thus, it is essential that the teacher organize and develop a purposeful program for students who will not utilize mechanical drawing as a basis for a career. At the same time, mechanical drawing and design should provide the foundation needed by students planning to continue their studies in this area. Mechanical drawing and design as an exploratory course plays a significant role for those who wish to develop their potential in engineering, art, architecture, or industry. Thus it can provide both the basis for professions and the foundation of a richer and fuller personal life.

The program should be kept broad, flexible, and experimental. Numerous opportunities for designing should be presented to insure maximum creative individual and group development. The use of a wide variety of visual and graphic approaches will help to make the mechanical drawing and design course meaningful and practical to all students. The technical aspects of drawing, when stressed in relation to these creative experiences, will insure the highest possible development of technical skills.

Care should be taken to work in all important areas of mechanical drawing and design, but these skills should be viewed as a means to an end — the techniques that lead to developed creative work — rather than the end itself.

It is important that in all phases of mechanical drawing and design emphasis should be placed on the relationship of actual object to the drawing. Only in this way is visual perceptive ability developed which enables the student to think in three-dimensions, to visualize quickly and accurately, to build up a clear mental image of an idea. Serious consideration should be given to both directions to achieve this aim: the student should work from the object to the method of expression in drawing; and from idea, sketch and drawing to the actual construction of the object. Students should constantly be encouraged to seek examples of good design. Awareness of design through the ages and its relationship to present design forms will help the student develop esthetic sensitivity and encourage visual discrimination generally. The design of forms and the critical analysis of forms designed by others create our environment, structure our cities, and identify our culture.

Displays of visual materials should include a selection of classic designs of the past and expand into a full realm of present exploration in all areas of architectural, technical, industrial, and graphic design.

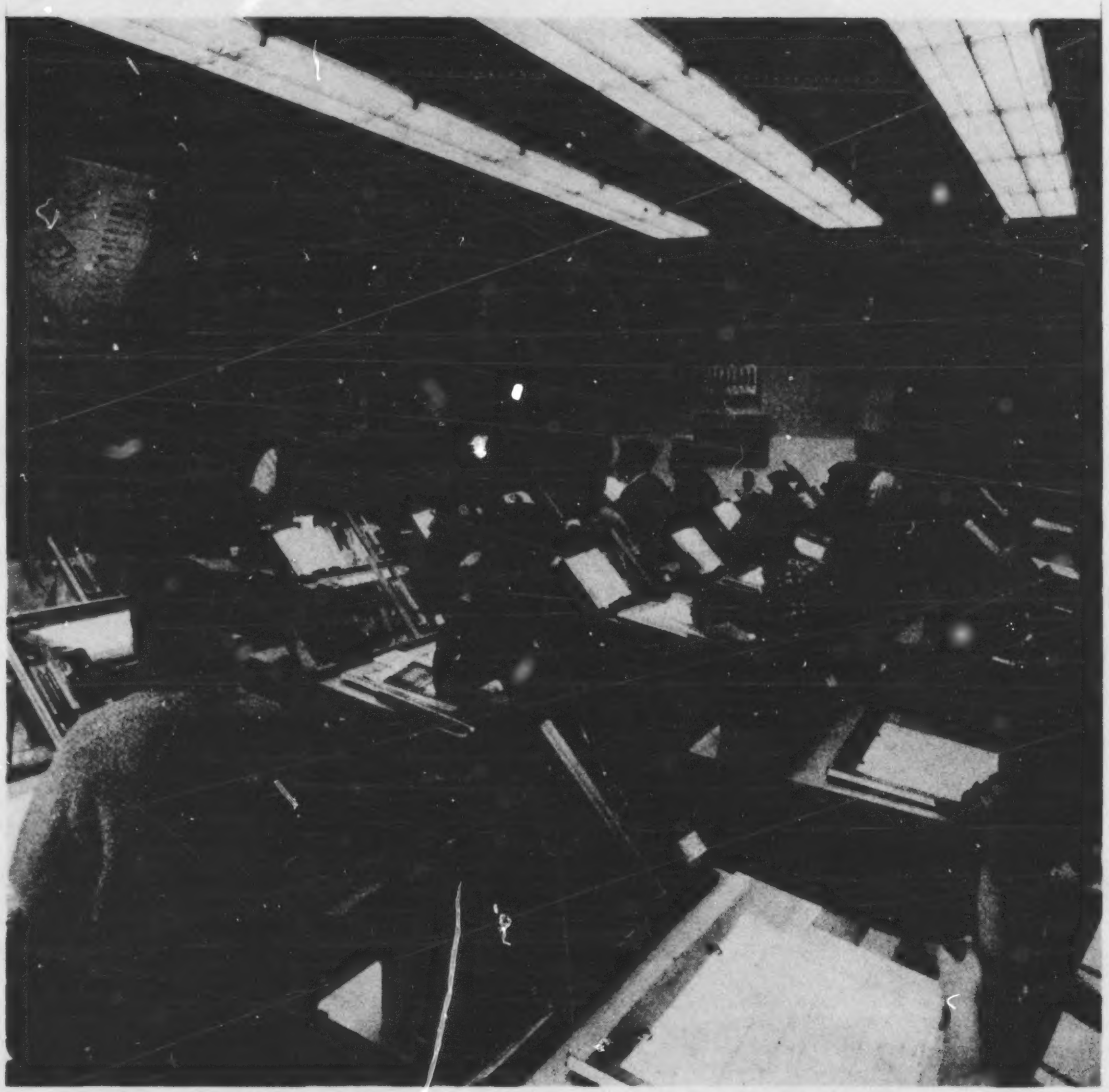
Mechanical drawing and design should be taught to meet the varied needs of students of different backgrounds and interests by providing activities that expand and enrich their experiences. The content of the course may vary from semester to semester in relation to changing community resources and local industries. The teacher is encouraged to be inventive in formulating each semester's work but has an obligation to explore the basic fundamentals of mechanical drawing design as suggested in this outline.

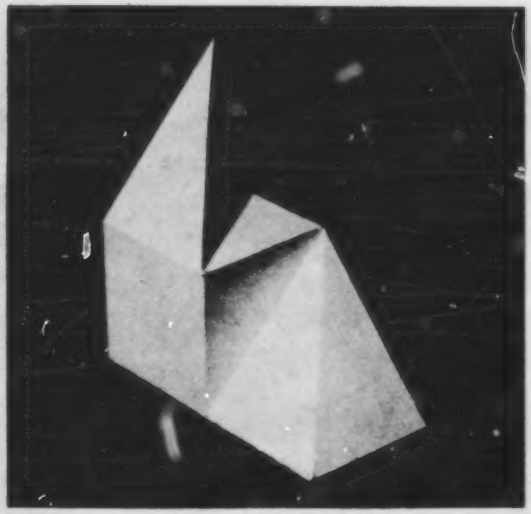
Mechanical drawing and design opens the way to a conscientious study of design through the potentiality of drawing as a language of self-expression. Recent trends in mechanical drawing and design emphasize the development of the student's esthetic imagination and his eagerness to originate individual designs while studying methods of technical expression. The development of these attitudes and abilities add another dimension to the personal growth of each student.

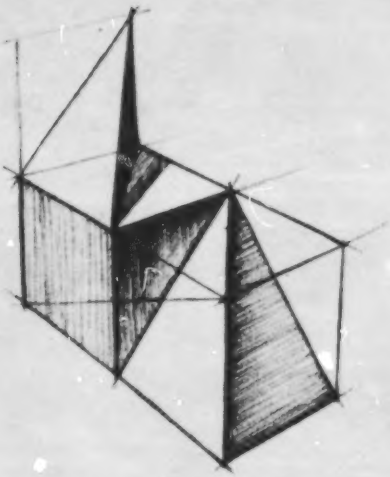
The need for self-expression is not limited to the fine arts. The creative two-dimensional and three-dimensional work being done in many classrooms can develop an appreciation for design in all areas of daily living. New creations, involving the design and structuring of spatial organization and materials, used with freedom, are having a visible effect on the styling of articles produced for everyday use.

The creation of form, which is determined by its function, reflects the artistic awareness of the designer and his knowledge of existing scientific and technical developments. A conscientious study of design leads to an investigation and exploration of these materials and methods of creation.

Emphasis should be placed on activities which will stem from individual creative experiences instead of the more common practice of "copying plates." Each of the different types of drawing lends itself to an involvement of research and planned activities which calls for a solution through creative ideas and the use of mechanical drawing and design as a means of expressing these ideas.





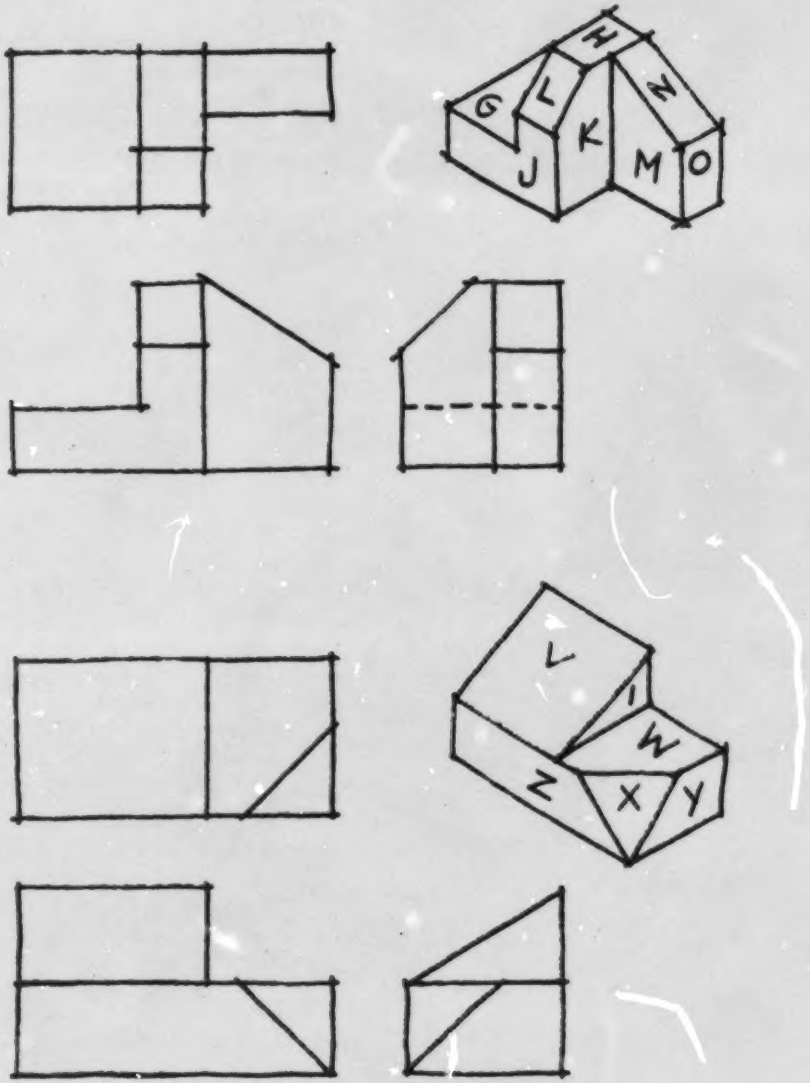


Students should be encouraged to explore and work with appropriate materials for two-dimensional and three-dimensional design. A wide variety of materials such as paper, cardboard, plastic, wood, and metal can be used. Such work should be shown from time to time in school and in local exhibitions. Wall space should be set apart for flat exhibits. Illustrative pictures, charts, or other exhibits especially adapted to the work of the class should be constantly in view. Such material should be changed continually as class projects progress, each exhibit illustrating facets of the subject under discussion.

Whenever possible the activities identified in this syllabus, "Mechanical Drawing and Design," should become an interdisciplinary approach between the fine arts and the industrial arts departments. In order to profit from the particular abilities and skills represented by each of these services, this syllabus should be translated into a course outline involving the techniques and skills inherent in each of these services.

Sketching is a natural and effective way to communicate ideas. The nature of sketching lends itself to a free, formulative expression of recording new ideas or changes in previous ones. Because it is mainly based on a pictorial or three-dimensional representation, the visualization approximates the actual form. In sketching, lines made with a free arm movement suggest a greater flexibility for potential changes, while the increasing freedom of visualizing ideas encourages a broader range of possibilities. Since visual communication is the basis for mechanical drawing and design, it is suggested that freehand sketching be practiced at the beginning of the course.

Sketching techniques may be based on a variety of methods such as parallel and angular perspective, isometric drawing, oblique drawing, and orthographic projection. A brief analysis of one or all of these methods will provide the student with a foundation of representing an idea graphically. (These methods are more fully described under Mechanical Representation.) In the beginning it is most desirable to work from actual objects. In this way the students develop a sense of proportion between the drawing and the structure, so that in reading a drawing, they may have the ability to visualize not only the shape but the size of the object represented. Assembling a group of geometric forms made from scrap lumber provides a basic challenge to the drawing of fundamental shapes found in actual objects. As soon as the students have gained sufficient ability in sketching they will have greater freedom in developing their own ideas.



Important factors in making of drawings are the types and qualities of lines used. These lines are common throughout the world and represent an international graphic language.

It is suggested that students draw rather lightly during their early development of a sketch. Heavier lines should be applied after the shape and position of the various parts are satisfactory.

The width or thickness of a line is called the weight by architects, engineers, and industrial designers. This weight or thickness is acquired by the degree of hardness of the pencil, by the manner in which the pencil is sharpened, and the amount of pressure used. A range of pencils is used for different types of drawings.

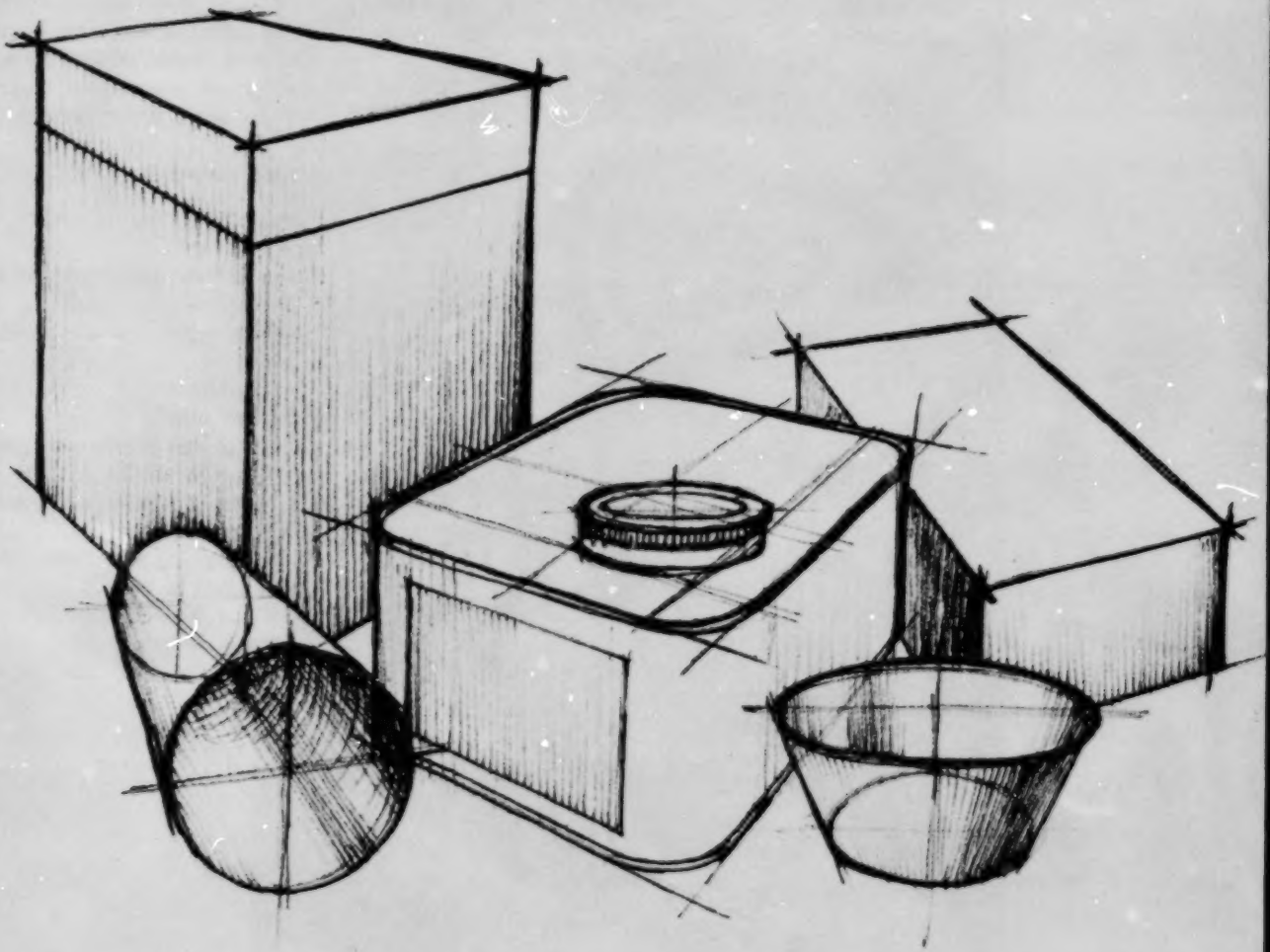
Practice in freehand lines is best achieved by a free arm movement. This helps to insure smooth, clean drawings. A straight line can best be drawn between two points. Usually, horizontal lines are drawn more easily from left to right. Vertical lines are generally best drawn from top to bottom. Swift, deliberate movement of the entire arm is essential for drawing straight lines in any direction.

Students should be encouraged to draw lines in different directions first, then they should close these lines to form shapes of a geometric nature. Blocking-in space requirements and the proportional breakdown of this space to locate other areas, details, and curved surfaces should be practiced to insure versatility and proficiency in judging proper relationships.

As the ability to draw and locate planes is developed, students are able to combine them to form solids, prisms, cylinders, cones, and spheres, which are the basic forms of all objects.

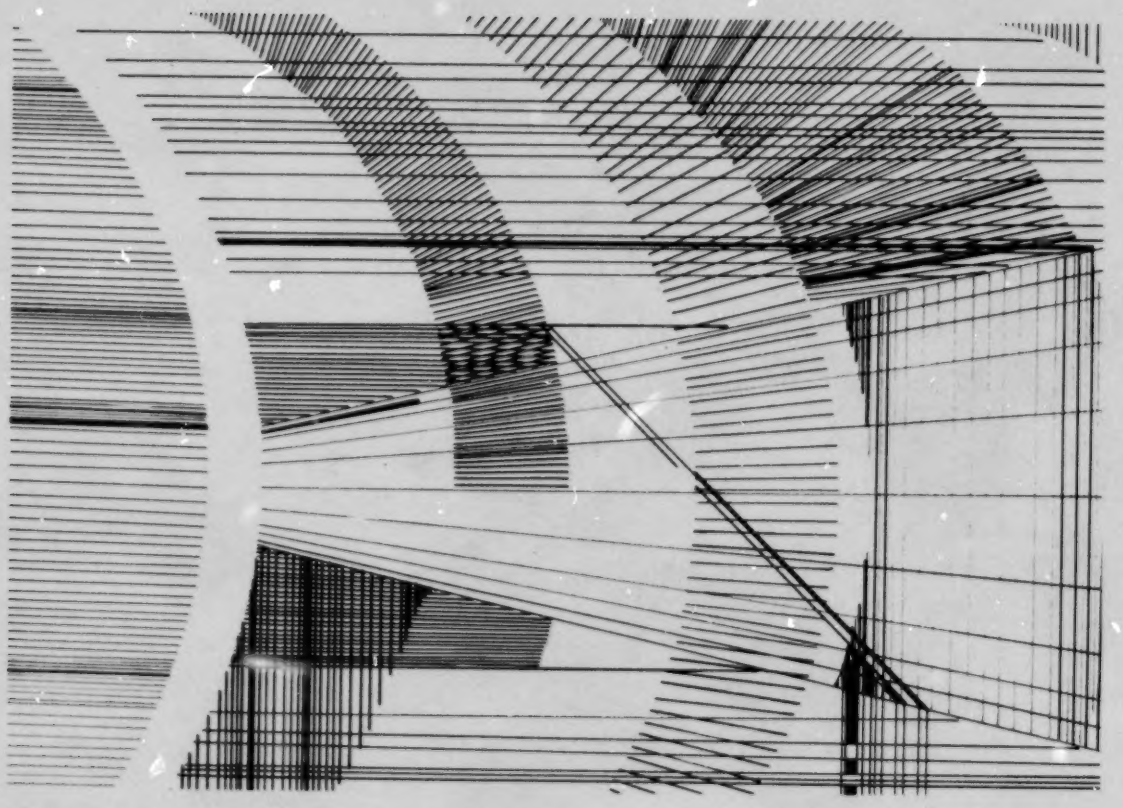
Graph paper is often used by designers in making freehand working drawings, especially in designing objects with free-flowing curves. Basically, a graph drawing is made on paper blocked off in vertical, horizontal, or angular divisions. The size of the divisions depends on the proportional size of the project. Measurements are easily read by plotting a few main points of the outline of the object on the divisions of the graph paper. The concept of scale is used to enlarge the smaller square to actual size, if a final pattern of the design is needed, or to scale down an object that is too large to a proportion which will fit on the paper to be used.

The freedom of graphically expressing ideas may be easily attained through sketching — the freedom of sketching is only attained through continuous practice.



MECHANICAL REPRESENTATION

Within the general areas of mechanical representation are all of the potential methods for precise definition and development of creative ideas. Each specific area provides a means of expression and a method for visual explanation of the unique qualities of the mental image, as well as providing the student with the fundamental grammar of reading drawings and relating them to actual forms.



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Drafting Instruments

The first step to good draftsmanship is to awaken the interest and pleasure in the use of the draftsman's tool. It is suggested that the student spend time exploring with the T-square, triangles, and compass, freely making thick or thin lines in a variety of ways developing contours, shapes, values, textures, and patterns.

Basic Materials

architect's scale, triangular
drafting tape
drawing board (recommended minimum: 20 inches x 26 inches)
drawing paper, tinted or white
erasers
erasing shield
irregular curve
pencil pointer (sandpaper type)
pencils, 6H, 4H, 2H, HB, 2B
penknife, X-acto knife or single-edge razor blade
protractor
set of drafting instruments of good quality
sketch pad or book
T-square, 24-inch blade
triangles, 450° and a 30° - 60°
waterproof drawing inks, black and color

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Suggested Activities

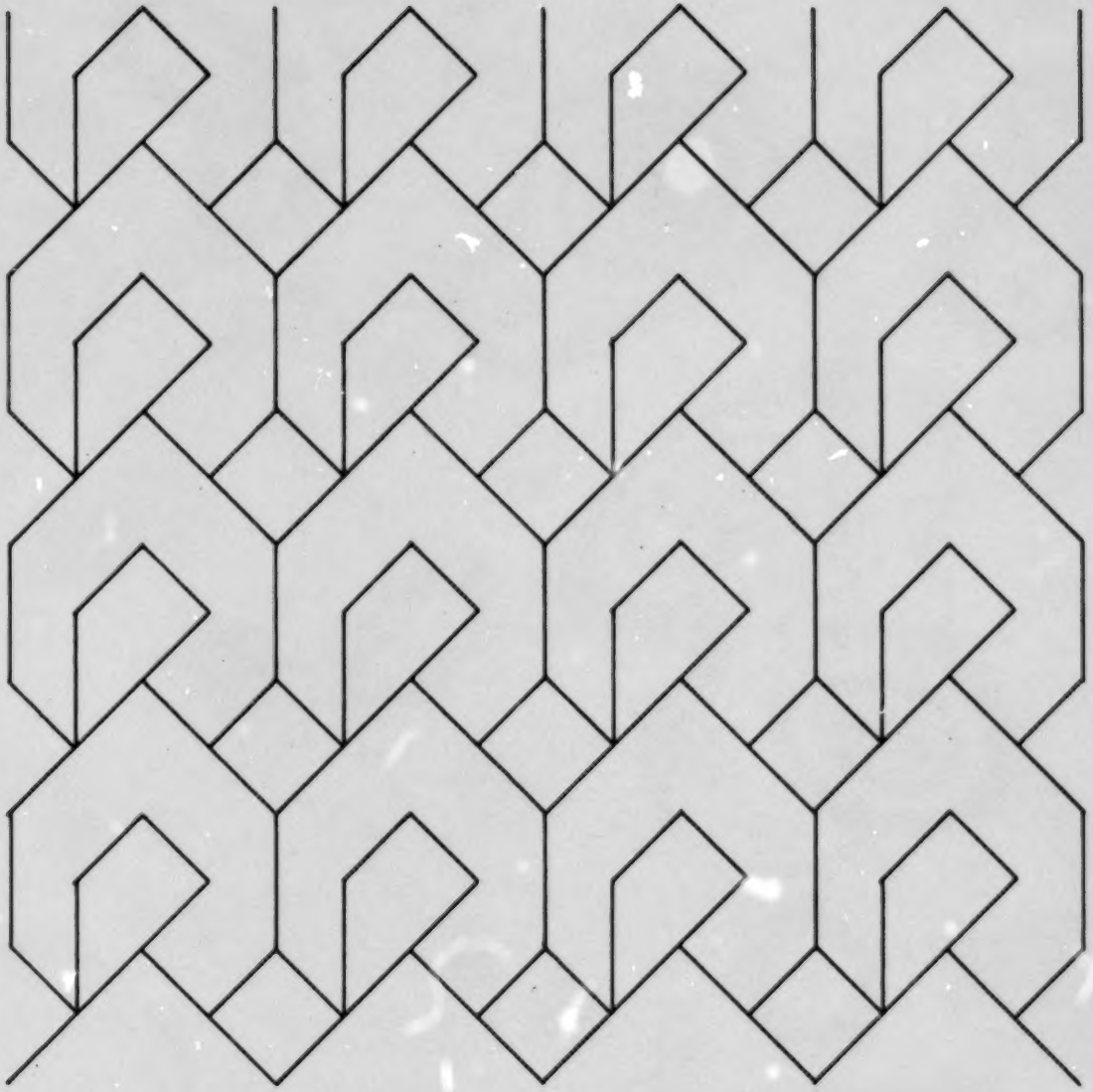
Freely experiment with all of the instruments and equipment to find the potentialities and limitations of each.

Create a design using thick and thin lines to develop contours, shapes, values, textures and/or patterns.

Create patterns with limitations of vertical and horizontal lines such as interlacements and such patterns as formed by concrete blocks, bricks, shingles, and street paving.

Create pattern using inclined lines such as Maltese cross, and 6- to 24-point stars.

Create pattern from circle and arcs such as concentric circles, spirals, and loop ornaments.



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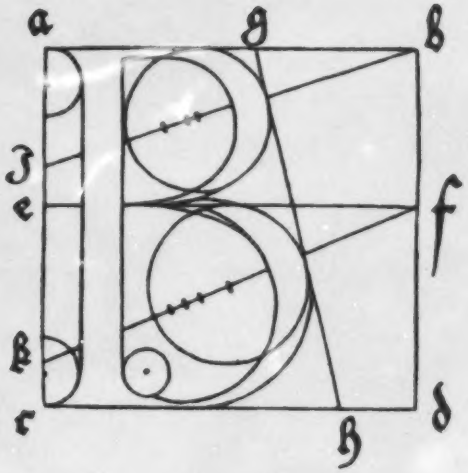


Lettering

The facility to letter with ease is a most important asset to a designer, engineer, architect, or draftsman. The graphic representation of objects would be incomplete without numerals, notes, and specifications.

The current trend in lettering lies in the direction of simplicity. Legibility and appearance are basic requirements. Either vertical or inclined gothic, single-stroke lettering is acceptable.

Good lettering is characterized by neatness, smoothness, uniformity of lines and sizes, good construction, correct proportion, and proper spacing.

To become adept at lettering, the student should:

Acquire a knowledge of the proportions and design of each letter and the order and direction of the strokes used.

Learn to compose letters in the formation of words and to space words properly.

Basic Knowledge

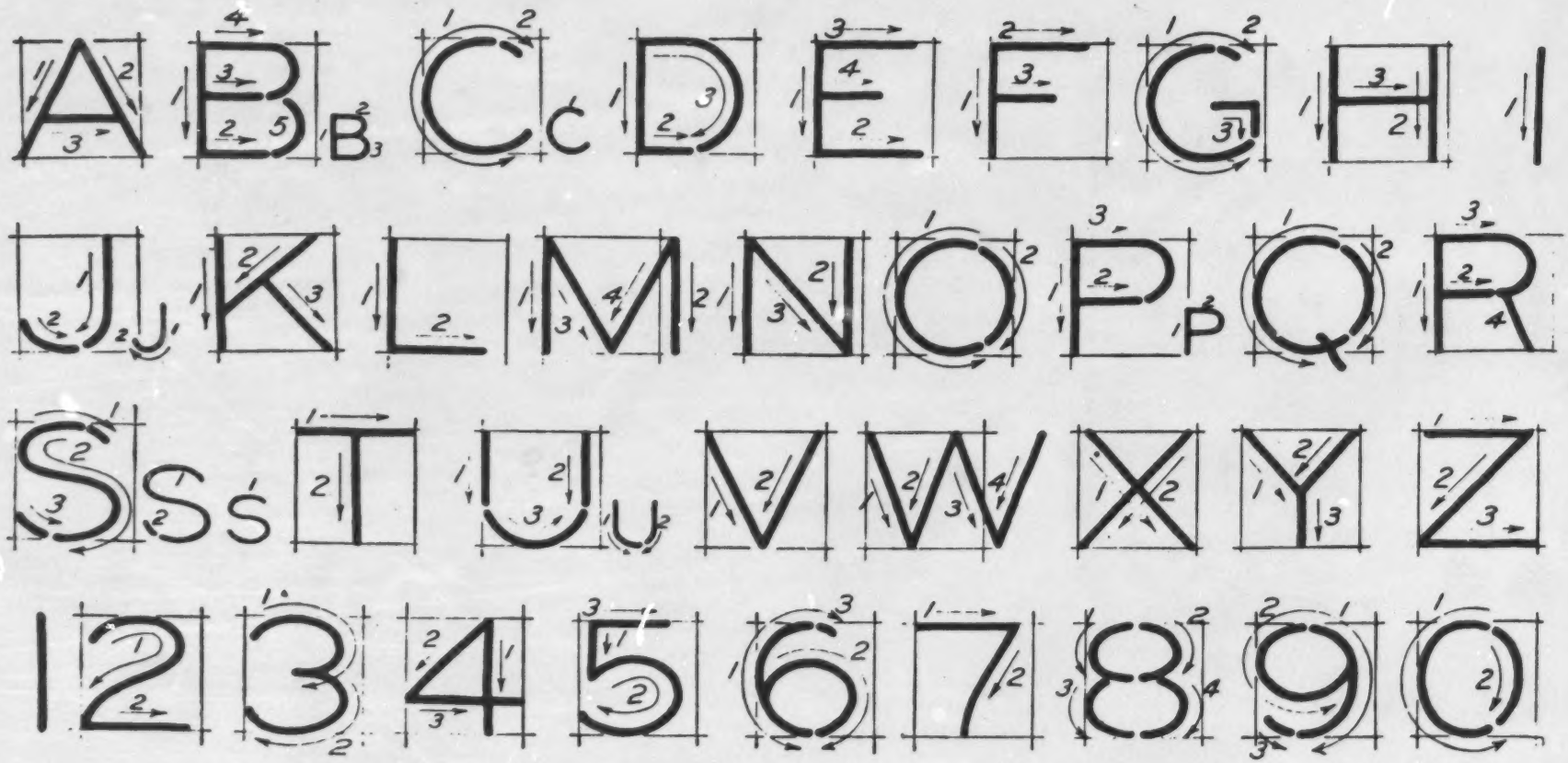
proportion of letters
guidelines
lettering strokes
balance and stability
vertical capitals
vertical numerals
vertical fractions
vertical lower-case letters
inclined letters
spacing in words
composition

Suggested Activities

Practice lettering straight-line letters singly or in words.

Practice lettering curved-line letters singly or in words.

Compose suitable layouts and letter groups of words, titles, notes, and/or directions.



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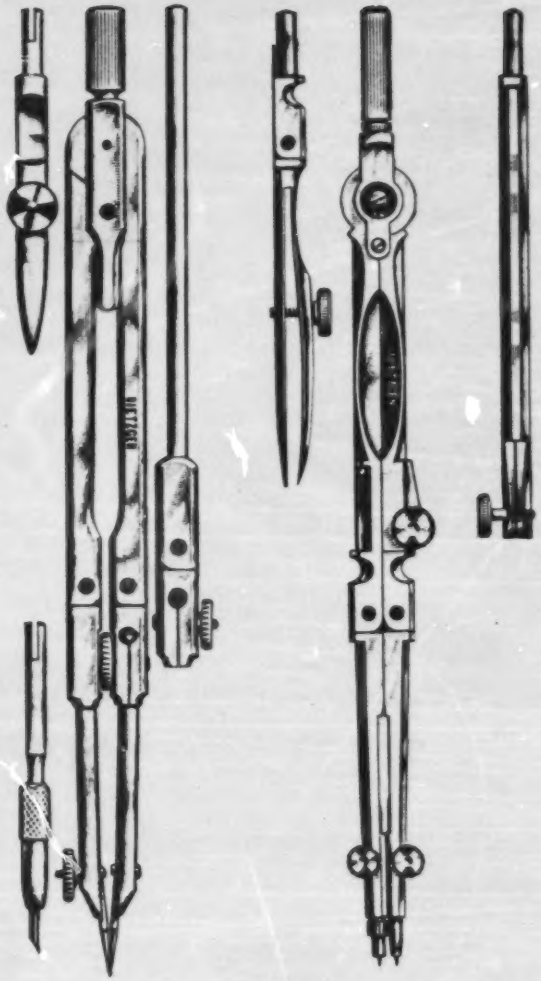


Geometric Constructions

Geometric constructions have important uses in making drawings and in solving problems by diagrams and charts. The lines forming views on mechanical drawings can usually be located with the instruments and equipment of the draftsman. However, it is sometimes necessary or convenient to use geometric constructions. Many of them will be encountered in the working of ordinary problems, while others often occur in the solution of problems in engineering design and advanced mathematics courses.

Basic Knowledge

to draw a line through two points

to draw a line parallel to another line

to erect a perpendicular to a given line

to divide a given straight line into any number of equal parts

to reduce or enlarge linear dimensions

to lay out an angle

to bisect an angle

to copy an angle

to construct a triangle, an equilateral triangle, an isosceles triangle, a right triangle

to locate the center of a circle

to draw a line tangent to a circle

to draw an arc tangent to two straight lines

to draw a tangent to two circles

to draw a regular hexagon

to draw a pentagon in a circle

to draw an octagon in a square

to approximate a noncircular curve with circle arcs

to lay off the approximate length of an arc on a straight line

to draw an involute

to draw an involute of a circle

to draw a spiral of Archimedes

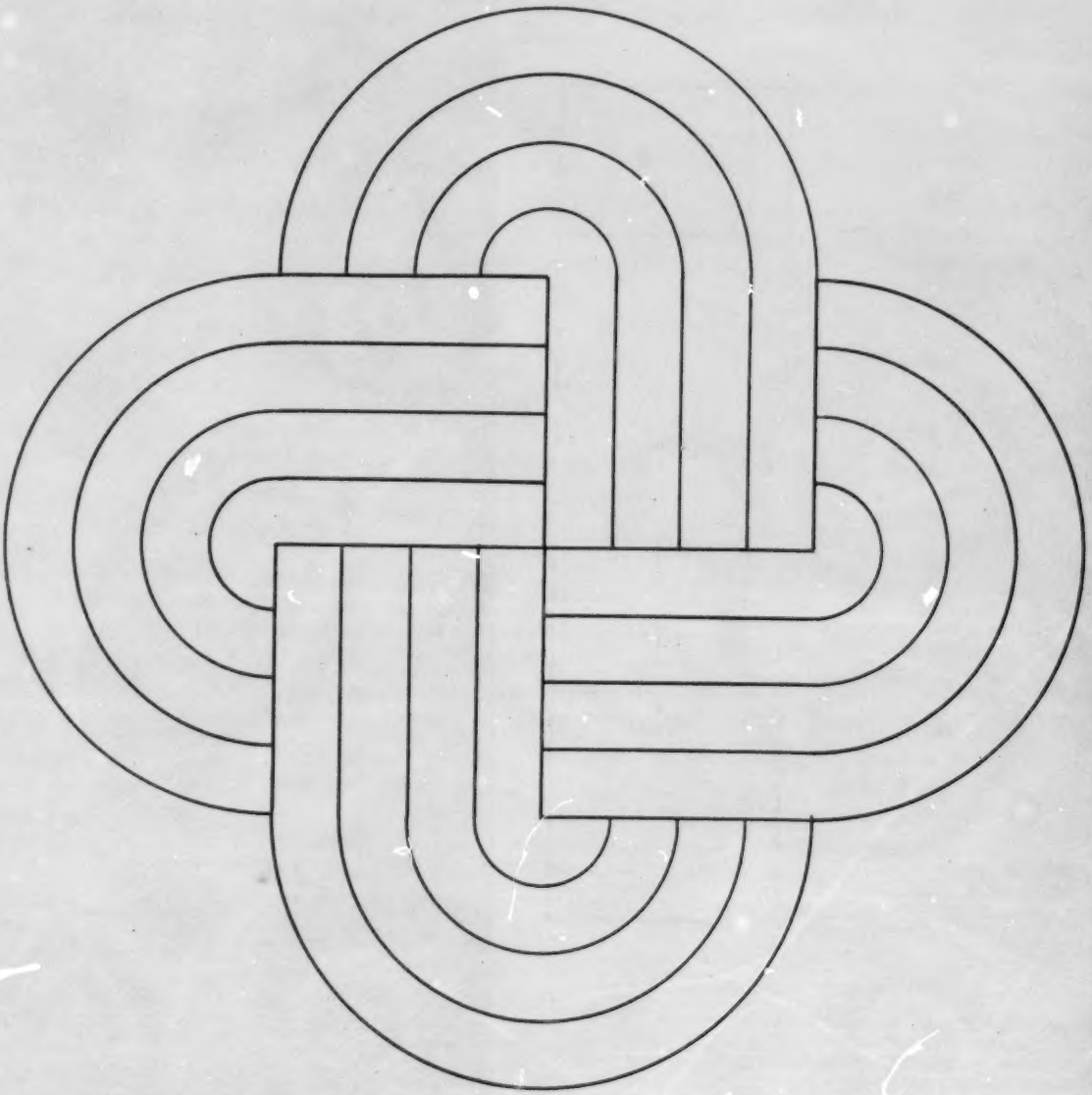
to draw an ellipse

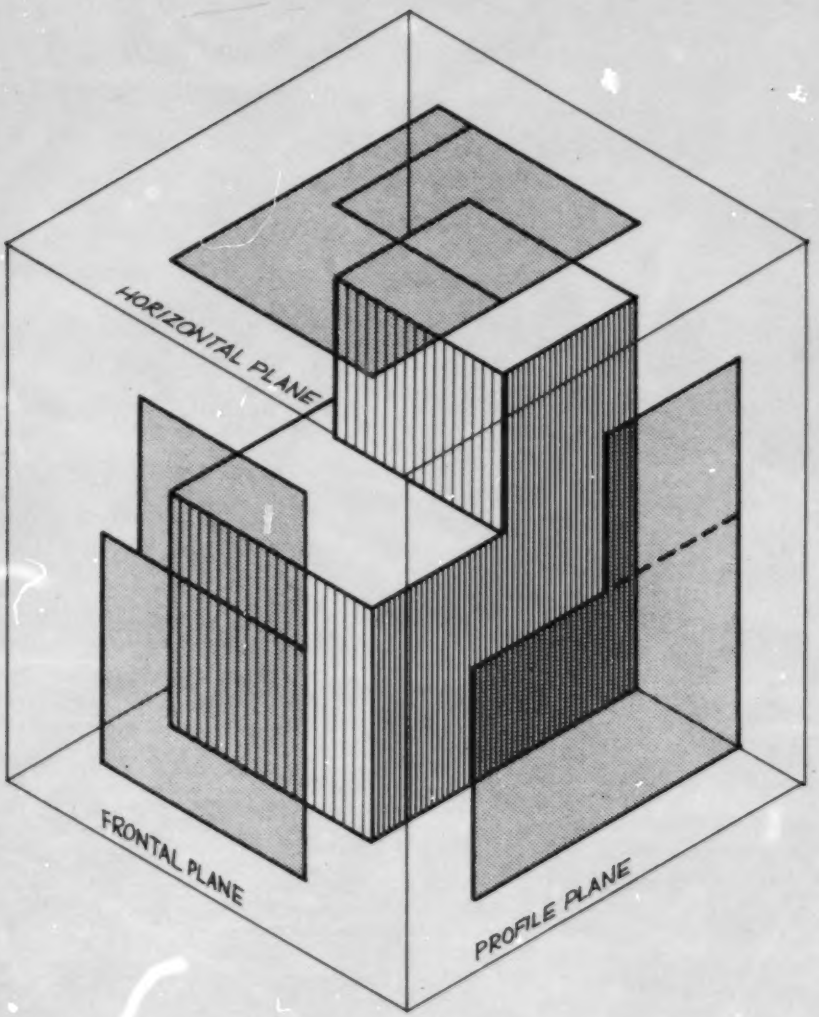
to use diagonals

Suggested Activities

Draw each of the geometric constructions.

Draw symmetrical designs based on any of the geometric constructions.




HORIZONTAL PLANE
FRONTAL PLANE
PROFILE PLANE

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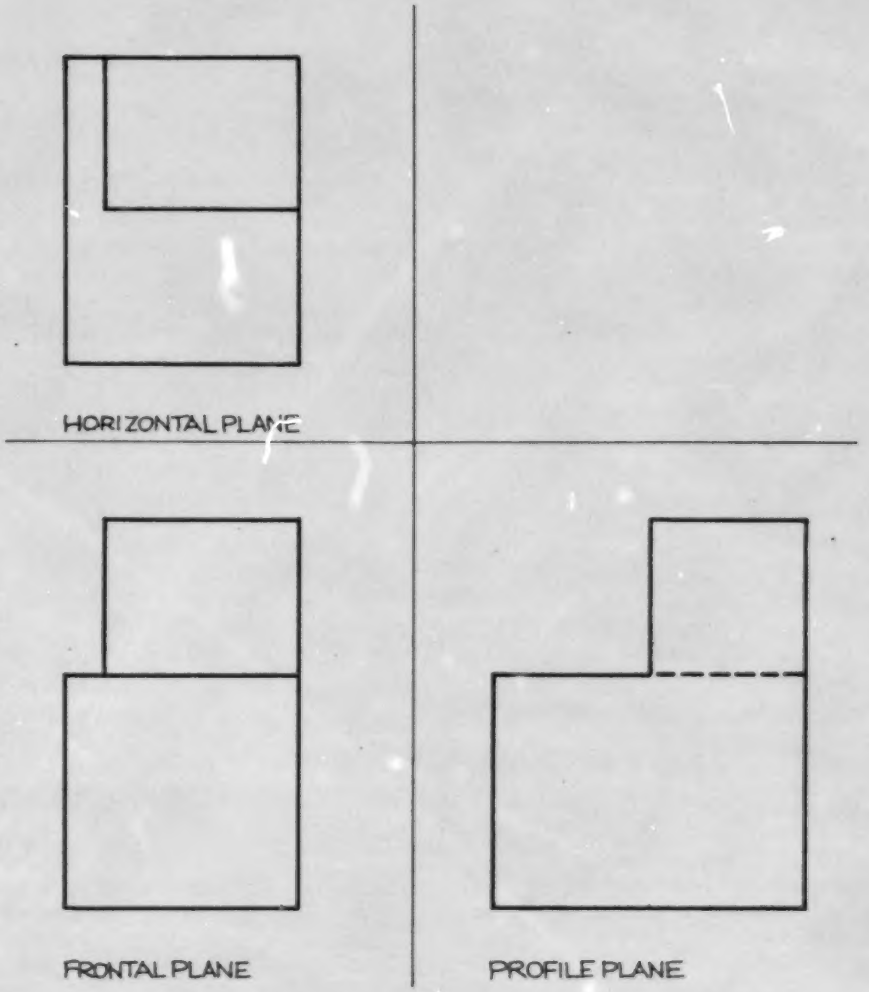
HORIZONTAL PLANE
FRONTAL PLANE
PROFILE PLANE

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Orthographic Projection

All objects are three-dimensional. In pictorial representation an object is drawn to give the illusion of three-dimensional shape in one view. This type of drawing is often not adequate as a working drawing because it cannot convey constructional features, or convey accurate shape and size information.

Orthographic projection views a three-dimensional object in such a way that all of the surfaces are shown in their true dimension and in true relationship with each other. In order to do this, each face of the object is projected onto a plane parallel to it by means of projectors or rays formed by lines of sight. The common planes of projection (frontal, horizontal, profile) are at right angles to each other when viewing the object, but are then rotated from the front view to the flat plane of the paper.

From the six principal views (front-, back-, top-, bottom-, left- and right-side) two or more related views are selected to describe the object. The most common selection is a choice of front-, top-, and right-side view. The front view should show the most characteristic shape of the object or its natural appearance when observed in a permanent or fixed position.

Any one orthographic view can only show two dimensions. The missing third dimension must be looked for in an adjacent view.

In drawing an orthographic view, it is customary to represent all edges and intersections as a part, even though some features may not be visible from the direction in which the view was taken.

Hidden features are then shown in these views by hidden object lines. Dimensions, notes, and specifications are then added to these views to completely identify the object for production.

Basic Knowledge

projection box
selection of views
position of views
relationship of surfaces, edges, corners
language of lines
dimensioning
scale drawings

Suggested Activities

Relating object to drawing:

Using simple objects, select, and sketch the necessary orthographic views.

Select a few geometric forms (these may be cut from scrap lumber) and combine them to create an interesting form or object.

Analyze the object carefully; then sketch the minimum number of orthographic views, in proper relation to each other, to describe the object adequately.

Design a simple object (paperweight, wastepaper basket, toy, tray, etc.); select the necessary orthographic views, dimension, letter notation of material, and finishing methods; then construct the object.

Interpretation of lines:

Given the actual object and drawings of three views, analyze the views to locate missing lines.

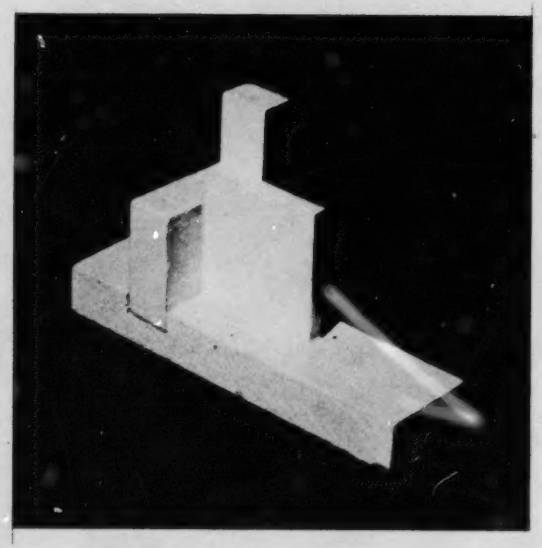
Given three views, analyze and sketch the object; then complete the views with the missing lines.

Interpretation of planes:

Given a pictorial drawing of an object and three orthographic views, letter the corresponding planes, lines, and edges.

Missing views:

Given two complete orthographic views, analyze, and draw the third view.



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Dimensioning

A drawing to be completely useful must show the shape of the object, its size, and other necessary information for constructing it. The shape is shown by lines. Dimensions tell the size or measurements. Information about material, number of pieces, and other details should appear in the title block or as a shop note.

Dimensions are placed so that they are easy to read. Usually all dimensions are placed outside the view rather than right on the view. Certain dimensions, if easier to read, may be placed on the view. Only the measurements needed for constructing the object should be shown. Dimensions should not be repeated in the several views.

A complete list of rules and illustrations of recommended practices in dimensioning should be obtained from American Standards Association, "Design and Dimensioning, Section Z-14."

Application of dimensioning should be related to the range of activities throughout the term's work.

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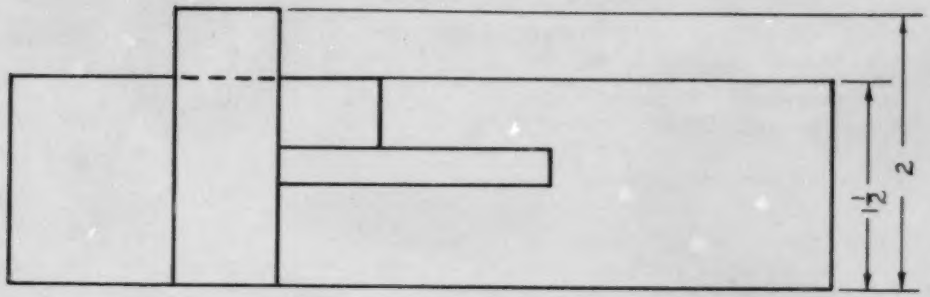

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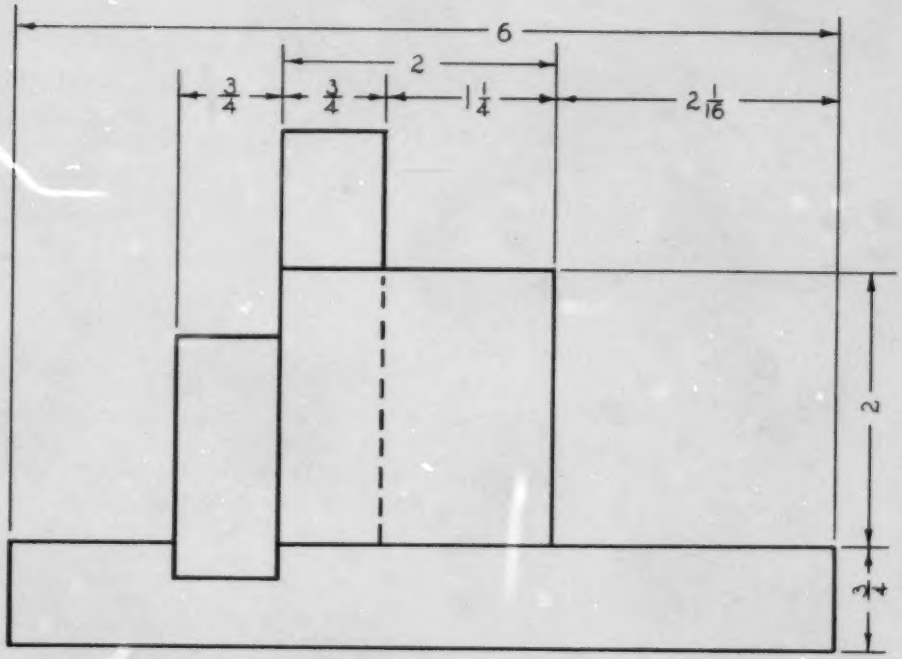

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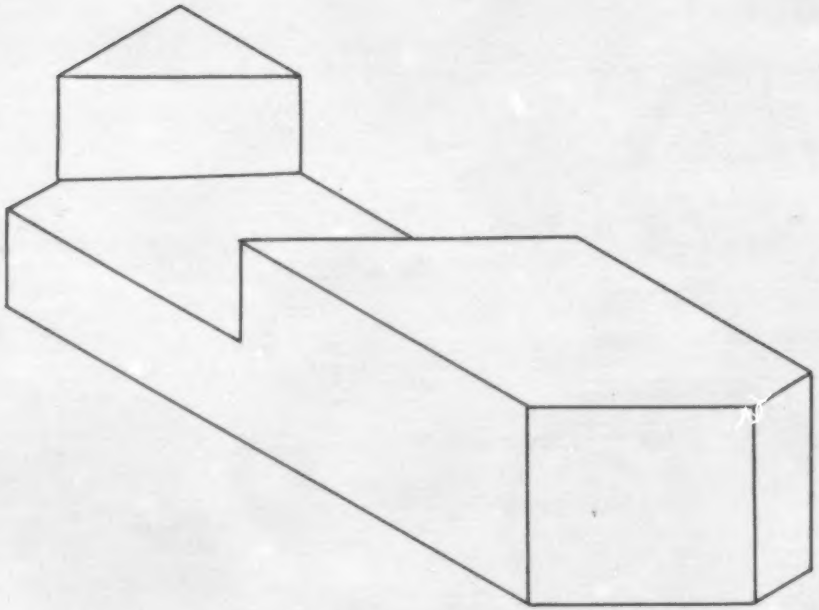
Pictorial Representation

• Isometric

Isometric drawings provide a graphic means by which the length, width, and height of an object may be represented in a single view. This is made possible by revolving and tilting the object so that it is seen from an angle at which its axes form isometric angles. The receding isometric axes make an angle of 120° with each other, an angle of 60° with the vertical axis, and angles of 30° with the horizontal. The lines of the object are drawn in their actual length, and the foreshortening effect is disregarded. The choice of isometric drawing as a pictorial representation is widely chosen for this particular reason.



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Basic Knowledge

isometric axes
nonisometric lines
circles
curves, arcs
isometric sections
dimensioning

Suggested Activities

Draw a simple grouping of slablike forms.

Draw a simple grouping of cylindrical objects including curves on right, left, and horizontal planes.

Draw imaginary objects which involve the use of offset measurements.

Draw any of the objects you have already constructed as an isometric drawing.

Design a simple mobile toy. Make an isometric drawing with dimensions, material, and color notations.

Use this method to formulate new ideas in all areas of creative design.

• Oblique

The simplest type of pictorial representation is the oblique drawing. This type of drawing is used frequently by draftsmen since it allows them to show the front face of the object in its true size and shape. Oblique drawing is also favored over isometric drawing for depicting objects of irregular shape more easily.

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The oblique axes are three lines, two of which are always perpendicular to each other, while the third is a receding line that may make any convenient angle with a horizontal line. As in isometric drawing, the actual dimensions (or scaled dimensions) are measured along the main axes and any lines parallel to them.

When the angles of projection are at 45° and the receding axes are full scale, the drawing is called a "cavalier" drawing. If the angle is 45° and the depth scale is reduced one-half, the result is known as a "cabinet" drawing.

Basic Knowledge

oblique axes
cabinet and cavalier
selection of view
nonoblique lines
circles on receding plane
curves and arcs on receding plane

Suggested Activities

See activities listed under isometric drawings.

• Exploded Views

Pictorial drawings are often used to show exploded views on production drawings; to illustrate parts lists; and to explain the operation of machines, apparatus, and equipment.

The exploded technique differs from the other principal views in that the parts of the object appear to be caught in midair at the instant of being blown apart. In this way, it is possible to visualize clearly not only the general shape of the object but the manner in which the parts fit together. Referral or identification letters or numerals are usually used to specify dimensions and quantities.

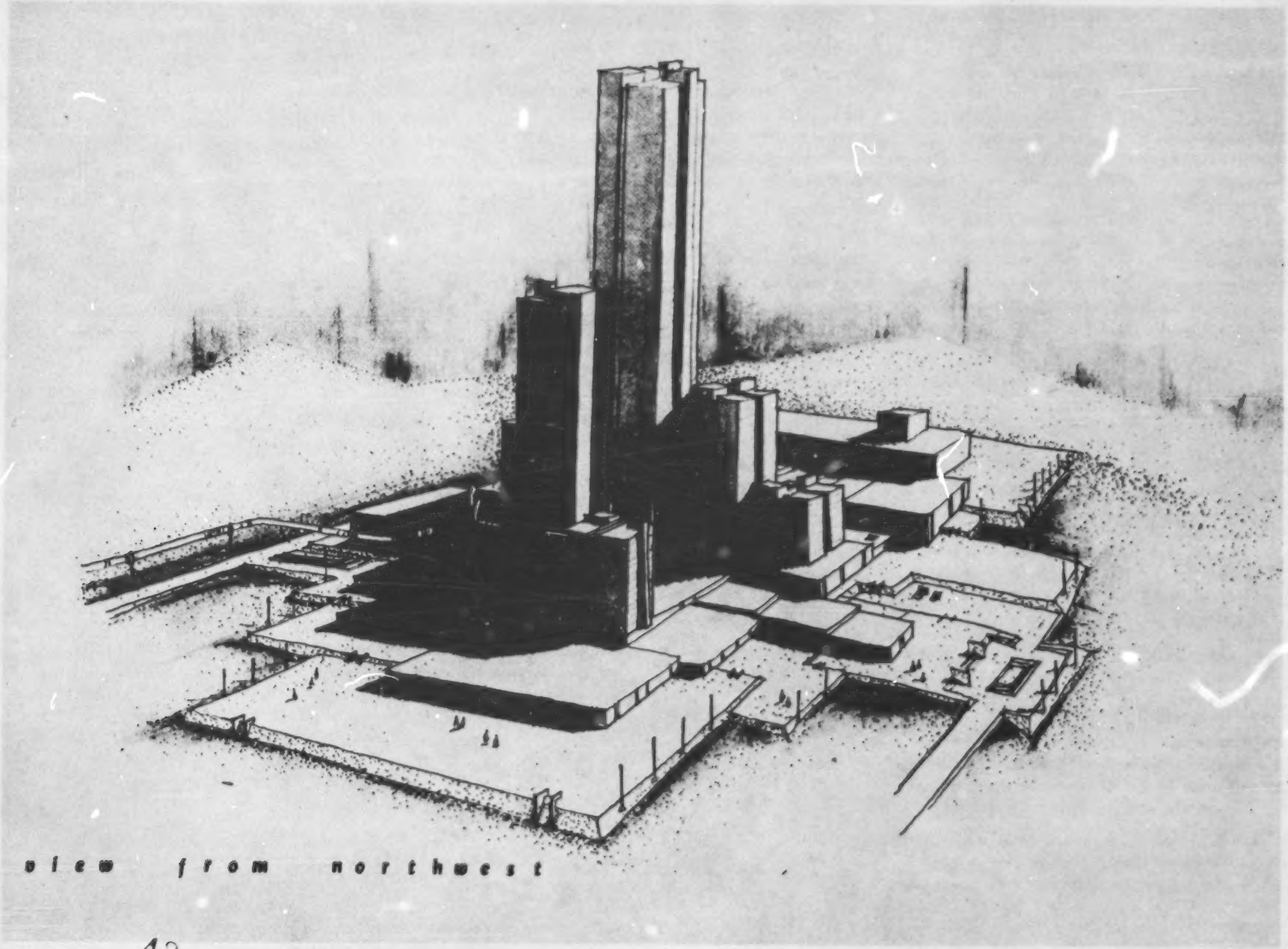
Basic Knowledge

isometric drawing
oblique drawing

Suggested Activities

Select an object made up of several parts and draw it as an exploded view revealing its construction.

Design a simple toy. Draw an exploded view; provide dimensions; letter a list of materials; and note color.



view from northwest

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• Perspective

Perspective is a science used to represent objects on a flat surface as they appear to the eye. This pictorial device is used effectively to create the illusion of space and depth and to represent objects in a natural manner.

Because objects drawn in perspective do not give true shape and dimension, perspective is rarely used for industrial purposes. Industrial designers and architects make much use of this means of graphic communication, however. A proposed new house or school, when drawn in perspective, gives an illusion of natural reality.

Basically there are two kinds of perspective drawings. Parallel or one-point perspective is a type of drawing in which one of the principal faces of the object is parallel to the picture plane.

Angular or two-point perspective, though more difficult to draw than parallel perspective, is more frequently used for pictorial illustrations. With angular perspective, the object is turned or the observer views it at an angle instead of directly from the front as in parallel perspective.

Basic Knowledge

nomenclature: station point, horizon plane, ground plane, picture plane, vanishing points
parallel perspective
angular perspective
oblique perspective
cylindrical perspective

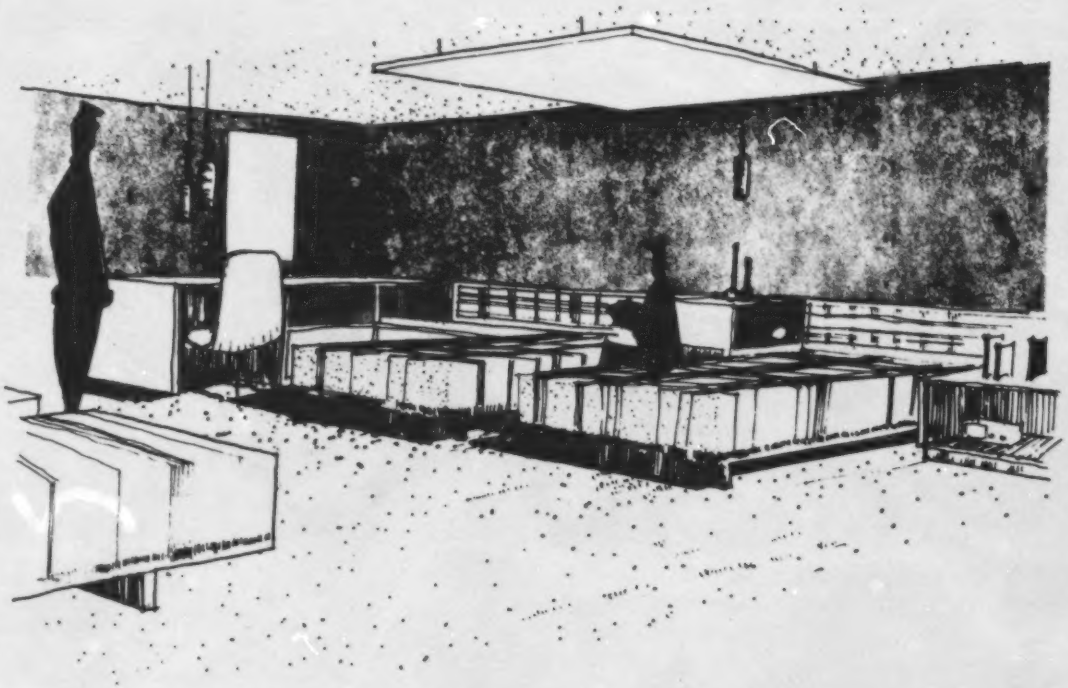
Suggested Activities

Draw an imaginary arrangement of geometric forms using parallel, angular, and/or cylindrical perspective.

Draw the interior of the classroom, a hallway, or a room at home.

Draw the exterior of a house, a group of buildings, the school, and/or a proposed cottage.

Use this method to formulate new ideas in all areas of creative design.

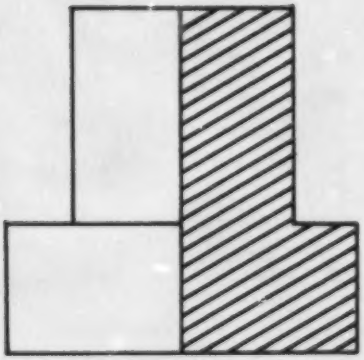


Sectional View

There are occasions when an object is too complicated to be shown effectively in the ordinary orthographic projections. In such cases, a sectional view is made — a representation in which a part of an object is imagined to be cut or broken away. Whenever material has been cut for sectioning, the cut surface is indicated by section lining or "crosshatching." To indicate specific material of the object, appropriate symbols are used.

Basic Knowledge

conventions: cutting plane, cutting plane line, section lining
full section
half section
offset sections
special sections



Suggested Activities

Construct an object of wood. Cut the object to form either a full section or a partial section. Draw a sectional view of the object.

Draw a sectional view of any object you have previously made or have available.

Draw a sectional view of each of the various joints in the making of furniture.

Draw a sectional view of a machine which is assembled of parts made from different materials.

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Auxiliary View

As most objects are rectilinear, they may be placed with their faces parallel to the three planes of projection. Some objects, however, contain inclined or oblique surfaces. In order to show these in true size and shape relationships, the surface is drawn on a plane or projection parallel to it and is called an auxiliary view.

Basic Knowledge

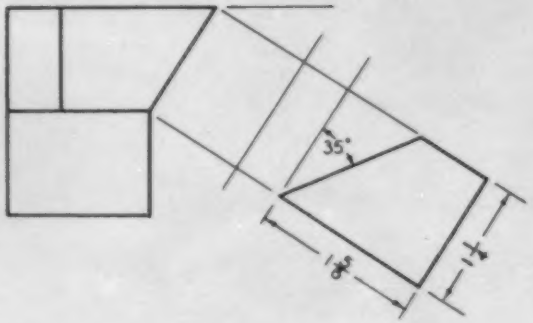
inclined surfaces and edges
foreshortened surfaces and edges
elevation auxiliary view
right or left auxiliary view
front or rear auxiliary view

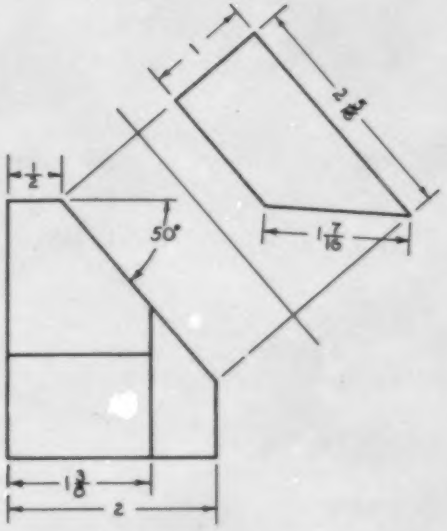
Suggested Activities

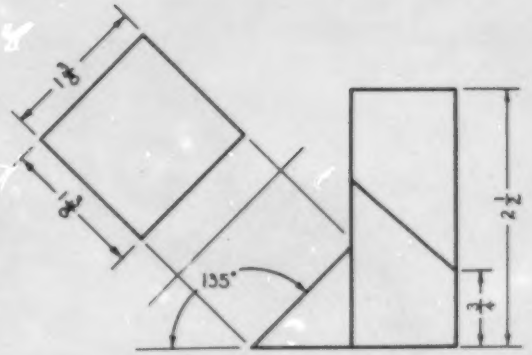
Construct objects of wood having an inclined face.

Develop an orthographic projection to show the true size of the inclined face through an auxiliary view.

Construct an object of wood or cardboard which will illustrate the three kinds of auxiliary views.







Development

Development refers to a drawing or pattern on one plane of the complete surface of an object that is intended to be cut generally from cardboard or metal sheets and rolled or folded into three-dimensional form. When the developed views are to be used as patterns or templates, they must be drawn with strict accuracy. Thus, development is an effective means of drawing and structuring three-dimensional objects for both industry and personal use.

Basic Knowledge

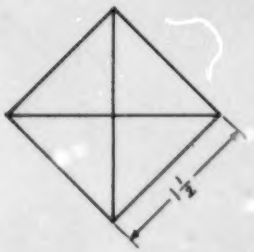
parallel development (prisms, cylinders)
radial development (pyramids, cones)
development by triangulation (transition pieces)

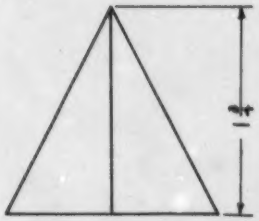
Suggested Activities

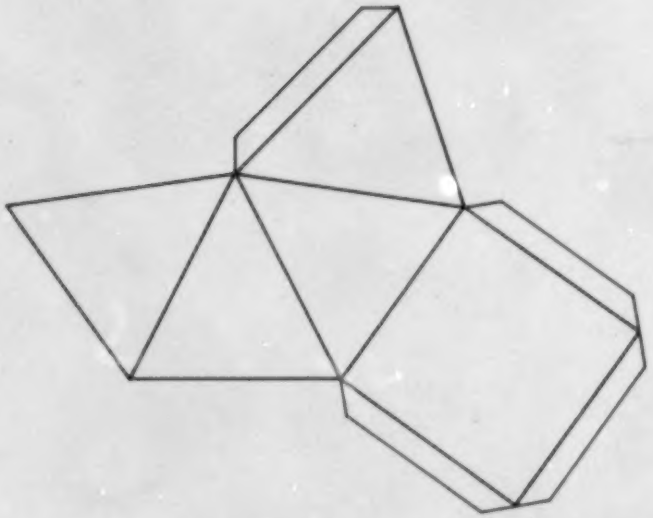
Develop and construct the five regular solids (tetrahedron, hexahedron, octahedron, dodecahedron, and iscosahedron) in cardboard or sheet metal.

Select any one of the geometric solids. After developing and constructing several, glue them together to create a larger symmetrical or asymmetrical form.

Design and construct an unusual container for an object or series of objects.







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Intersections

Whenever surfaces come together, there is a line common to both. When geometric surfaces such as cylinders, cones, and prisms intersect, this line of intersection must be located accurately for purposes of dimensioning or for the development of the surfaces.

Basic Knowledge

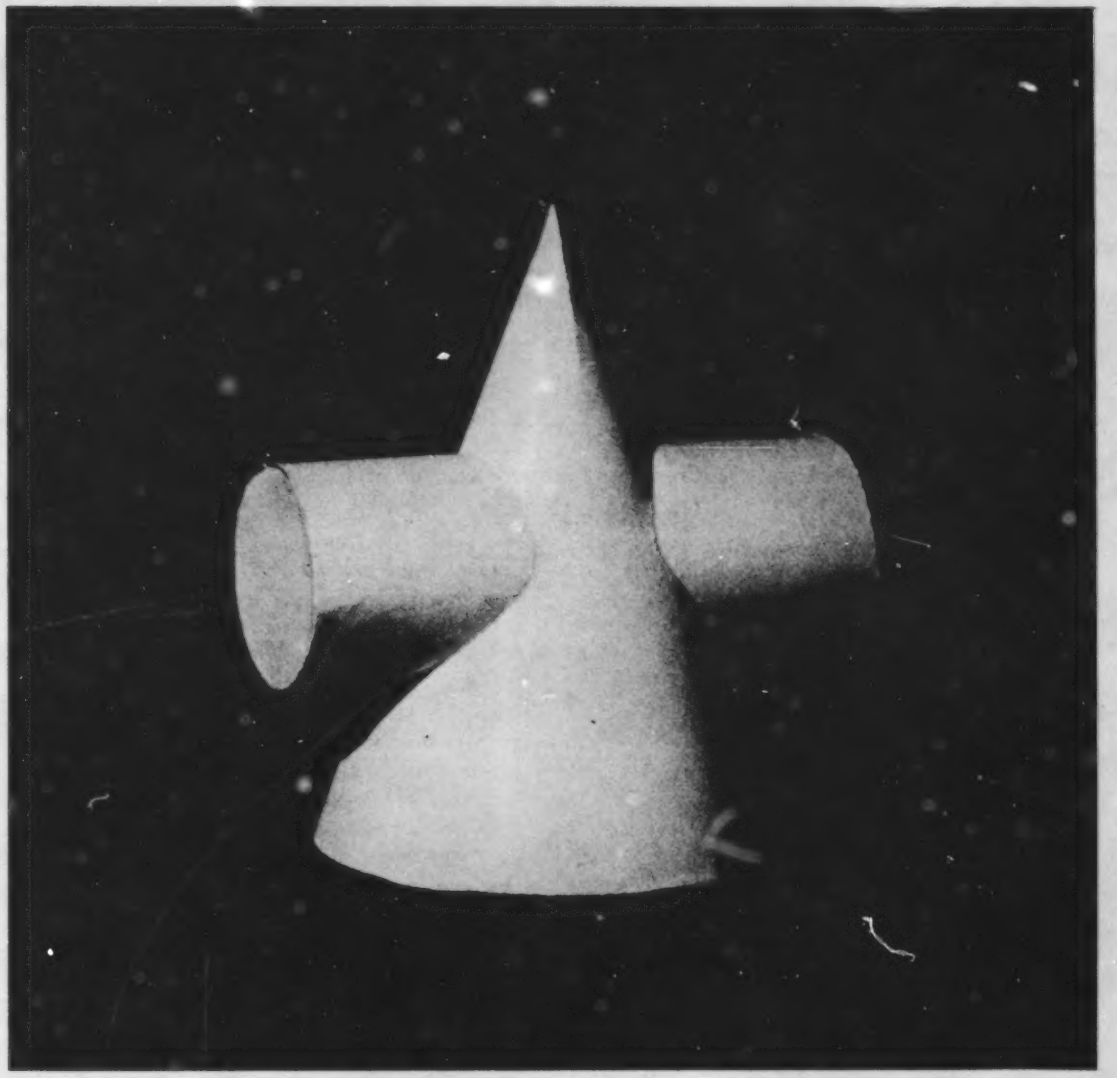
ruled surfaces
plane
single-curved surfaces
warped surfaces
double-curved surfaces

Intersection of:

- two prisms
- two pyramids
- a prism and a pyramid
- two cylinders
- a cylinder and a prism
- a prism and a cone
- a cylinder and a cone
- a plane and a surface of revolution

Suggested Activities

Construct in cardboard or sheet metal any of the intersections mentioned above.



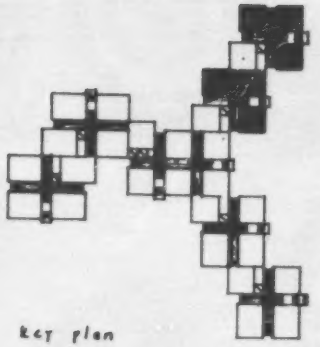
FURTHER STUDY

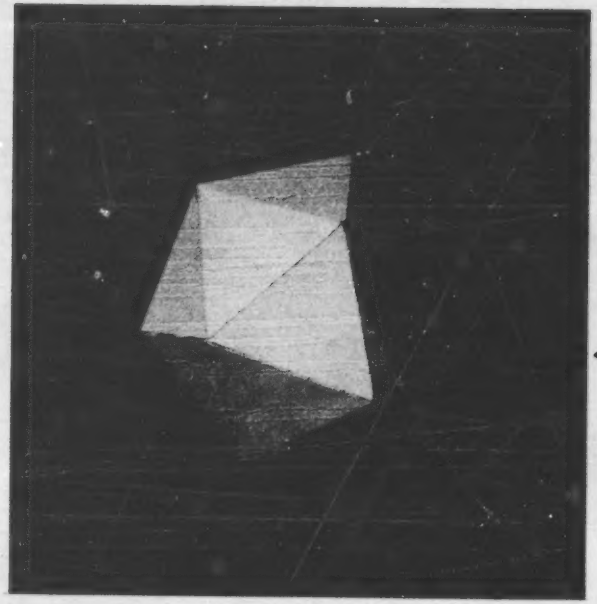
Further study of the concepts and techniques of mechanical drawing find application in both creative and technical areas. Intensification into particular areas should be suited to the student's needs.

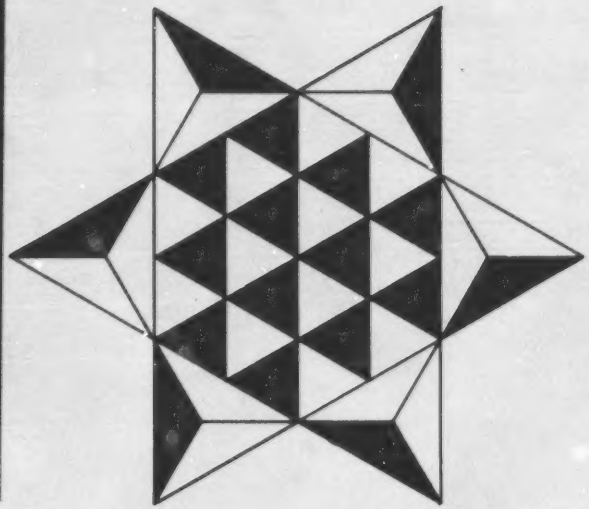
These phases of the program, and others developed by teachers and students, will help to form the basis of a productive and varied year's work. The resourceful teacher will utilize the talents and experience of local specialists from business and industry by inviting them to stimulate the class through demonstrations and discussions. Teachers should make every attempt to inspire creative design and provide for the interpretation of technical renderings and, when possible, the actual construction of articles.

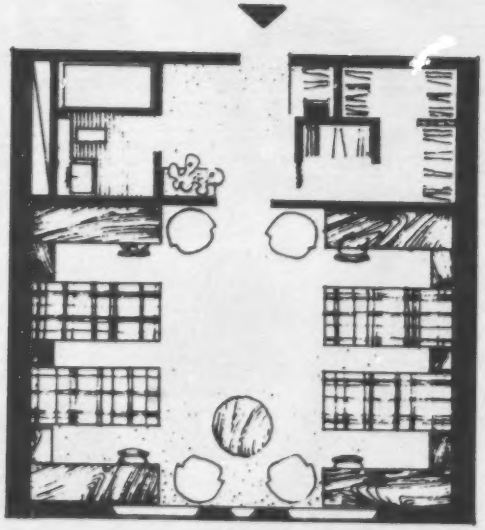
Audiovisual devices should be utilized fully to help dramatize the contribution of mechanical drawing toward a better society and a fuller life. Large corporations, such as the major automobile manufacturers, provide free films and filmstrips showing the development of manufactured articles. Such films may be used to illustrate the developmental process from the idea stage to the drafting table, to the scale model, and to the finished product. Drawings executed in class should be used by students to construct objects with natural or man-made materials. Therefore, it is necessary for students in basic art or industrial arts classes to acquire a knowledge of the nature of various basic materials frequently used, such as woods, metals, plastics, and cloth.

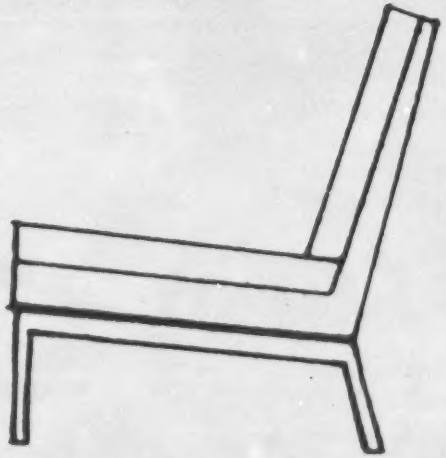
The fabrication of these materials and the use of tools and equipment in working with them are of primary importance. Resourceful teachers are encouraged to have the students explore the potentialities, the limitations, and the fabrication methods related to different materials when they are creating designs.

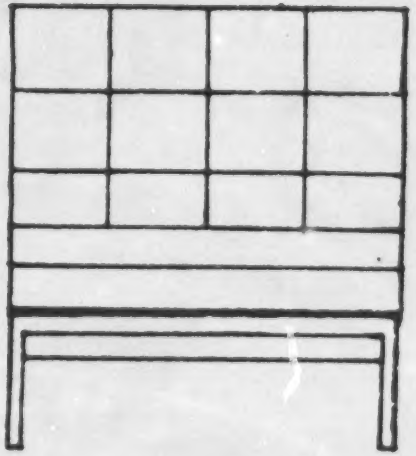

RCT plan











• Architectural Design and Drawing

One of the most challenging and meaningful areas of exploration which can be used for further study is that of architectural design and drawing.

In architectural design it is necessary to start with an understanding of the fundamentals of plane, volume, and space which leads to the ability to cope with the demands of the structure. Construction of simple space modulars, singly or in multiples, with a free use of materials, develops the foundation of architectural design. Emphasis should be placed on the organization of space in a plan concerned with the dynamics of function. This concept of shelter can then be extended to large scale social planning including civic and community centers. Laboratory exploration with architectural models, should be conducted as studies in materials, techniques, and space structure.

Architectural drawing is that branch of technical drawing which is devoted to the representation and specifications of buildings and structures of various kinds. Although the general principles are the same as for other technical drawings, there are certain methods of representation, conventional symbols, and practices that are necessary because of the relatively small scale used for architectural plans.

Basic Knowledge

fundamentals of plane, volume, and space
materials of construction
structures in space
floor plan; elevation
preliminary studies
presentation drawing
plot plan
basic design
exploratory design

Suggested Activities

Experiment with basic geometric forms as space modulars to develop an unusual structure.

Using the theory of negative and positive folds, construct covering or supporting structures which can be utilized in architectural design.

Design and cast a symmetrical and/or asymmetrical cement block which can be used as a decorative wall material.

Design a small shelter for the lake or seashore.

Draw floor plan and elevations.

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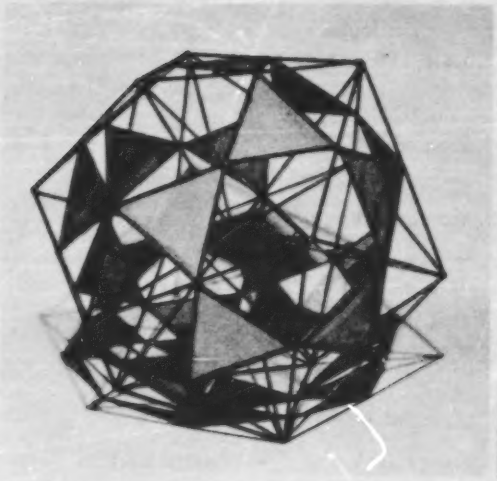

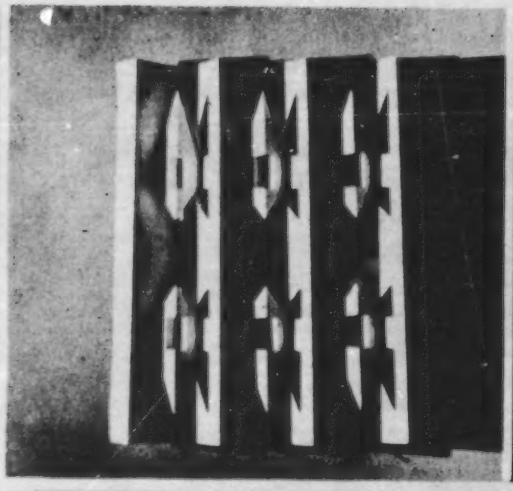

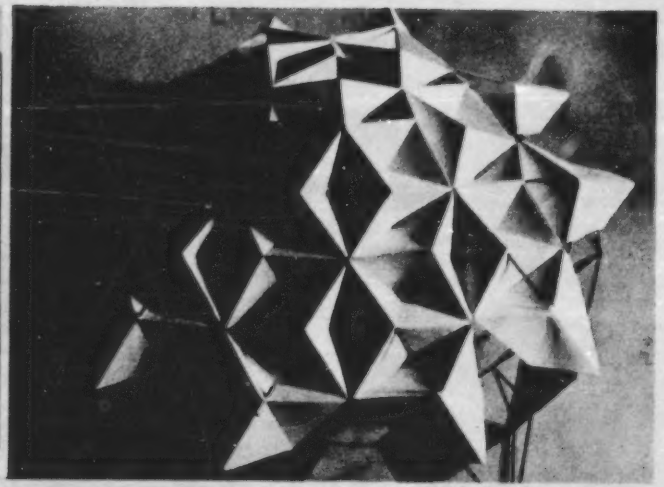

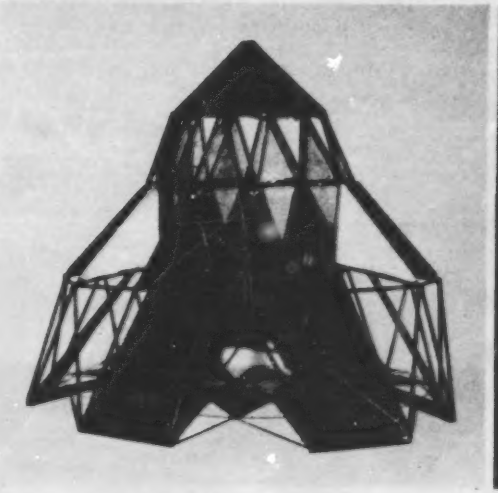

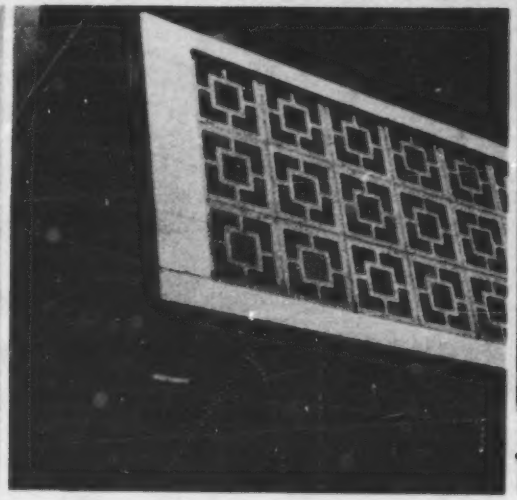

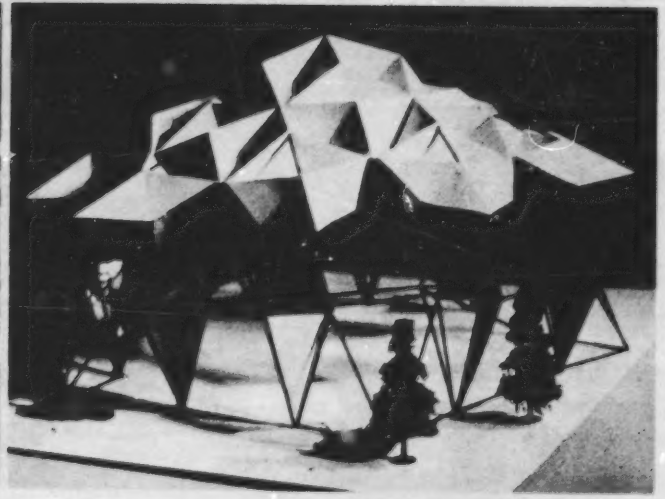

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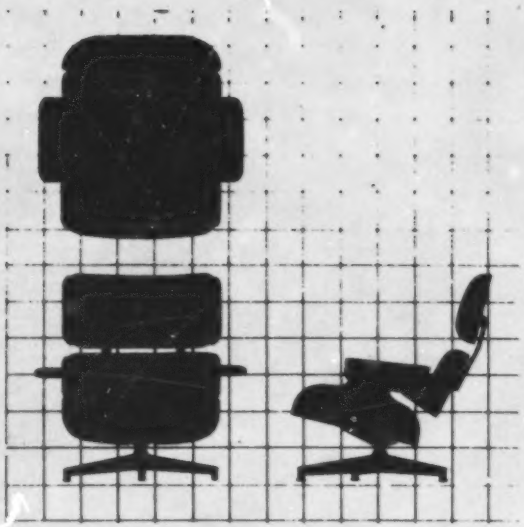

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• Industrial and Product Design

Under the general term of industrial and product design, is an ever-widening circle of activities related to the creation of functional objects. It includes an exploration into tools, mediums, and processes, whether technological or manual, to understand and employ the intrinsic quality of each as the basis for design problems.

Through experimentation with new materials and a questioning evaluation of current uses and processes, the student will gain an awareness of selections in his everyday, personal life.

Basic Knowledge

use of hand tools and machines
exploration of materials
study of shapes, surfaces, and textures
methods of mechanical representation

Suggested Activities

Broad areas for design possibilities:
furniture
household appliances
tableware
lighting fixtures
transportation vehicles
toys and games
community planning
playground equipment

• Tool and Equipment Design

The designing of individual or specific tools to meet a particular need is often a necessity. With a basic concept of drawing techniques, and by applying directed activity, a designed tool based on function and intrinsic nature of material can be created.

Basic Knowledge

tightening devices
cutting tools
driving implements
measuring devices

Suggested Activities

Design a rack which will hold a certain group of tools. The space for each tool should be so designed that it will hold only that tool.

Design a single tool which will fit all of the fastening devices on a bicycle.

62

• Charts, Graphs, and Nomograms

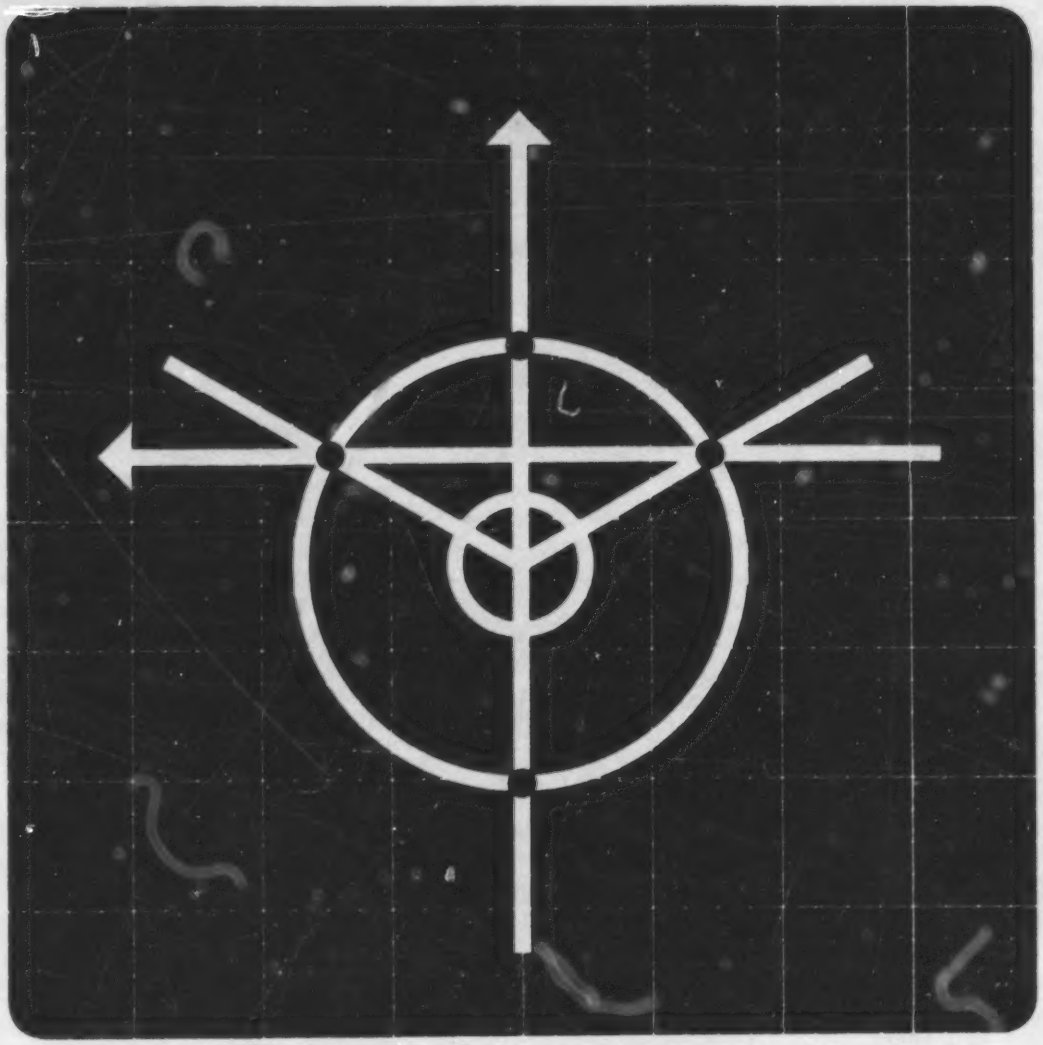
The use of graphic methods in tabulating data for analysis, solving problems, and presenting facts is now more meaningful and of greater value than ever before. This eye-catching technique constitutes a powerful tool for computation, analysis of data, and presentation of statistics for comparison or prediction.

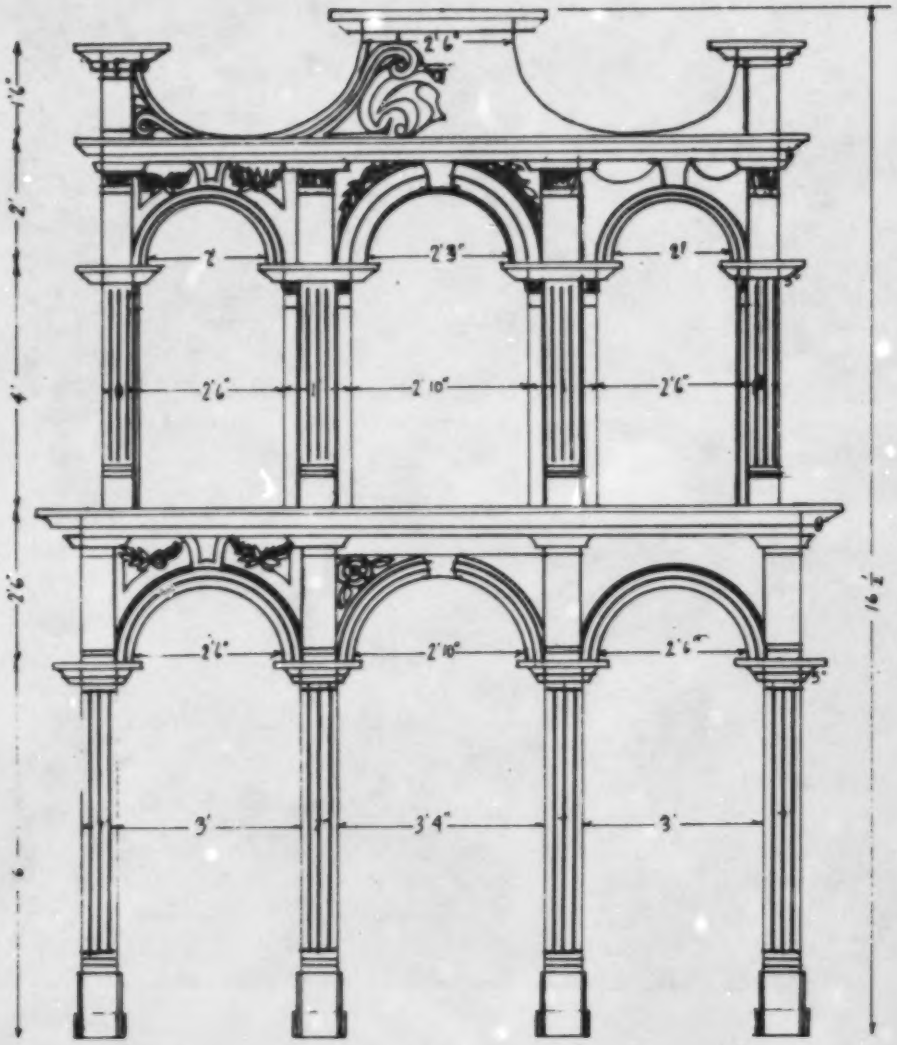
Basic Knowledge

single and multiple bar charts
pie charts
column charts
pictorial charts
trilinear charts
rectilinear charts
nomograms
polar charts
logarithmic and semilogarithmic charts

Suggested Activities

Problems should include charts and graphs made from a comparison of data compiled by the students. Bar, pie, column, and pictorial charts also lend themselves to an analysis of visual appeal through the use of design and color.





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FRONT ELEVATION · BASE CONSTRUCTION
·TURK IN ITALY· MICELSICY · MAY 1963

66

• Applied Design

The creative artist, in many specific areas, finds the need of expressing or clarifying his designs in a technical rendering so that they can be interpreted, reproduced, or constructed to his specifications. From the simple manipulation of geometric shapes to mechanicals for advertising, floor plans and elevations for stage design, and developments for package design, the artist can utilize the fundamental techniques and applications of mechanical drawing to meet his needs more effectively.

Basic Knowledge

use of drafting instruments and equipment
pictorial representation
floor plans and elevations
developments

Suggested Activities

Application of mechanical drawing procedures can be applied in the following areas:

stage design
package design
wood and metal sculpture
advertising design
jewelry
hobby units
model building

Technical Areas

• Working Drawings

Because of the vital importance of machines in a highly technical society, it is necessary to introduce students to this phase of mechanical drawing.

Working drawings are used to give information for purposes of manufacture, construction, or erection of an object, machine, or structure. A set of working drawings will include complete knowledge for production by conveying all the facts fully and explicitly, so that further instruction is not required.

Basic Knowledge

detail drawings
assembly drawings

Suggested Activities

Since orthographic projection is the basis of most working drawings, problems should include making a working drawing from the following sources:

detail drawings
assembly drawing from the details
detail drawings from the assembly
set of drawings from an exploded pictorial representation
set of drawings from a pictorial assembly
set of drawings from the design drawing

• Electrical Drawings

Recent advances in electronics, automatic controls, and electric power have brought all levels of society in contact with electrical drawings. For potential consumers of electrical energy and users of power equipment, a basic understanding of electrical symbols and circuitry is practical and useful.

Basic Knowledge

pictorial diagrams
wiring plans or diagrams
block diagrams
schematic diagrams
symbols

Suggested Activities

Activities should include problems in the four general types of electrical drawings, preferably related to some project or other experience of the student.

Design a wiring diagram for a proposed cottage.

Redesign the wiring in your present home to provide for the specific needs of your family.

Draw a diagram of a transformer, cell circuit, and telegraph key.

Draw a sectional view of a dry cell or a wet cell battery.

Diagram the layout of a lightning arrester for a house.

• Cams and Gears

A correlated study of different mechanisms or machine designs will involve the use of cams and gears. These machine parts are frequently found on working drawings. The student who is interested should know about their uses for generating and transmitting motion and how to represent them on drawings.

Basic Knowledge

plate cams
cylindrical cams
displacement diagrams
gear terms and formulas
gear teeth

Suggested Activities

Specific problems can be found in the various engineering books related to this area.

• Common Fasteners

A designer, engineer, or draftsman should have knowledge of the design and representation of the wide variety of permanent and removable fastening devices. Although there is a variety amounting to thousands, fundamental features found in all of these devices can be explained by an understanding of common types. Referral to appropriate standards or tables is strongly recommended.

Basic Knowledge

screw threads
bolts and screws
semiconventional external and internal screw thread representation
nut types and washers
set screws
keys
rivets
welded joints

Suggested Activities

A selected group of drawings should be chosen to give the student practice in drawing the simpler fastenings, and then proceed to problems of assembly drawing, where a great variety of common fasteners will be encountered. Emphasis should be placed on the sketching of fasteners and fastening devices rather than committing time to detailed drawings which are already illustrated in many publications. Where time permits, detailed drawings should be utilized.

Mechanical drawing and design is prerequisite for all advanced elective courses in mechanical drawing. As indicated by the flowchart, a student may follow a sequence that emphasizes the fine arts approach, the industrial arts approach, or a combination of them. Although the courses named on the chart should provide sufficient scope in most instances, if a school wishes to offer additional courses, it may do so with the approval of the Department.

Major Sequences in Mechanical Drawing

A major sequence in mechanical drawing requires one unit in mechanical drawing and design and two units of advanced courses which have been locally developed and approved by the Department. In addition, the pupil must pass a locally prepared comprehensive examination to be administered at the end of the sequence. The examination paper and all classwork submitted for evaluation must be kept on file in the school for one year subject to call for review by the Chief, Bureau of Art Education. Schools will be notified well in advance if they are to be selected for this sampling. Examinations must be graded by the local art teacher. The final mark will be calculated by adding the average of the three final grades given for the three courses in the sequence to the grade given for the comprehensive examination and dividing the sum by two.

Students must keep a notebook containing notes on the course content presented by the teacher as well as a record of projects undertaken, and of books, articles, or library reference works consulted.

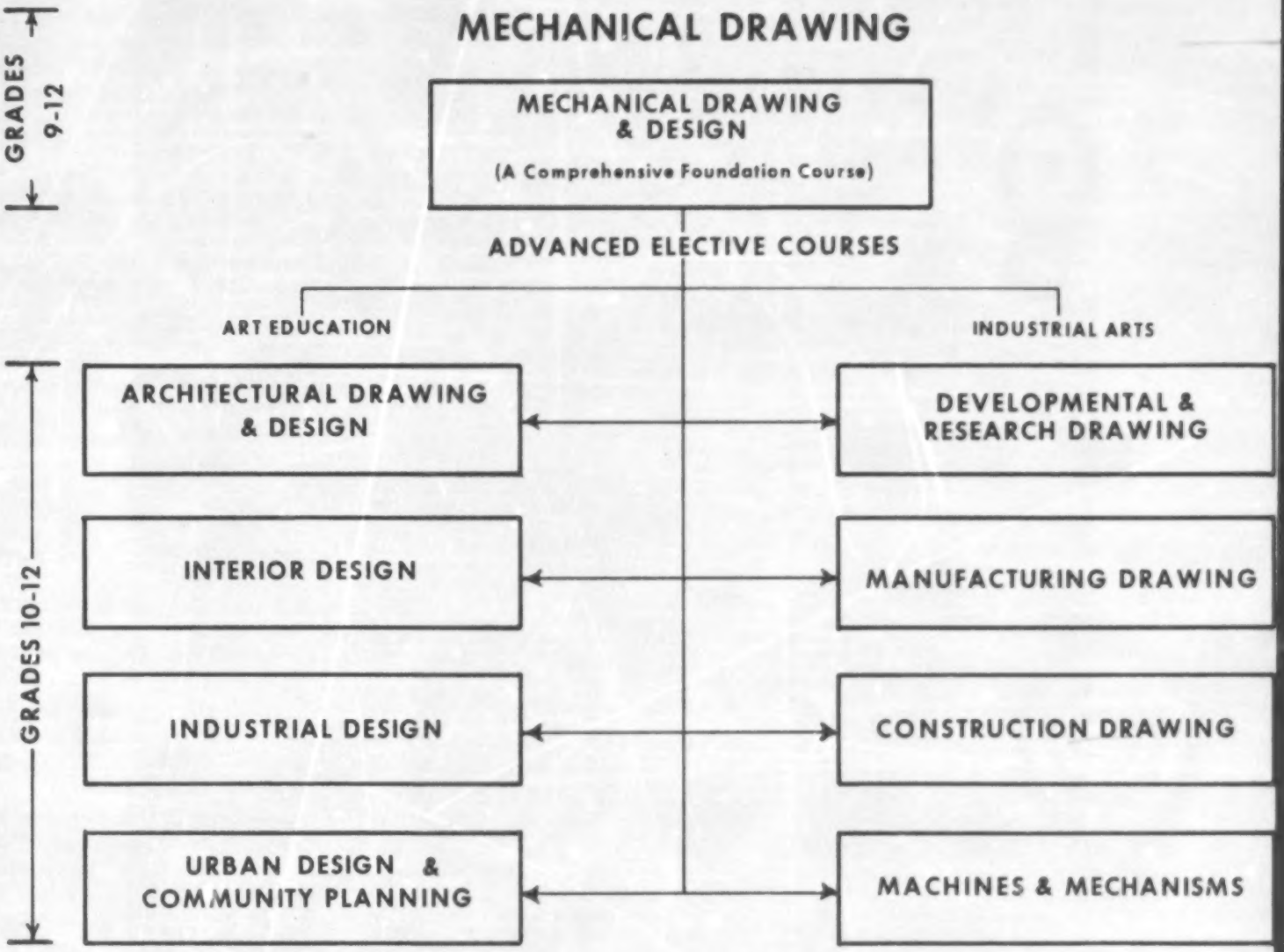
Teachers should regularly use a 35 mm. camera or other camera suitable for producing color transparencies or color prints of student work. The slides or prints may be used as part of the material submitted to the State Education Department for credit toward a Regents diploma. Color slides are especially effective for illustrating three-dimensional work. Slides submitted become the property of the State Education Department.

Procedure for Obtaining Approval of Locally Developed Courses

Advanced courses offered by a school are to be developed locally and two copies submitted to the Bureau of Secondary Curriculum Development for review accompanied by three copies of the form entitled "Application for Approval of Courses for State Diploma Credit."

The course descriptions should include the following:

1. The objectives in terms of skills, knowledges, and appreciations
2. A concise statement of the specific content of the course, together with some indication of the approximate number of class sessions or weeks to be spent on each topic or unit
3. Samples of the student activities to be undertaken, including those for all the students and some projects of greater depth or difficulty for individuals
4. An indication of the evaluation procedures and instruments to be used and a summary of the topics or of the objectives to be evaluated
5. A list of the textbooks and reference works to be used by students


MECHANICAL DRAWING
GRADES 9-12
MECHANICAL DRAWING & DESIGN
(A Comprehensive Foundation Course)
ADVANCED ELECTIVE COURSES
ART EDUCATION
INDUSTRIAL ARTS
GRADES 10-12
ARCHITECTURAL DRAWING & DESIGN
DEVELOPMENTAL & RESEARCH DRAWING
INTERIOR DESIGN
MANUFACTURING DRAWING
INDUSTRIAL DESIGN
CONSTRUCTION DRAWING
URBAN DESIGN & COMMUNITY PLANNING
MACHINES & MECHANISMS